SOURCE CONTROL FOCUSED FEASIBILITY STUDY
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
TOLEND ROAD
DOVER, NEW HAMPSHIRE

Prepared for:

Executive Committee of the Group of Work Settling Defendants
Dover Municipal Landfill Superfund Site

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SOURCE CONTROL FOCUSED FEASIBILITY STUDY
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LIST OF ABBREVIATIONS

AALs	ambient air limits
AR	applicable requirement, division of ARAR
ARARs	applicable or relevant and appropriate requirements (see also AR and RAR)
AROD	Amended Record of Decision
AGQSs	Ambient Groundwater Quality Standards
BCI	BCI Geonetics
BGS	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	constituent of concern
CWA	Clean Water Act
cDCE	*cis*-1,2-dichloroethene
DCA	dichloroethane; 1,1- or 1,2-
DCE	dichloroethene; 1,1- or 1,2-
DO	dissolved oxygen
EMP	Environmental Monitoring Program
Envirogen	Envirogen, Inc.
FES	Field Elements Study
FFS	focused feasibility study
FS	Feasibility Study
ft/day	feet per day
ft/ft	feet per foot
GeoInsight	GeoInsight, Inc.
gpd	gallons per day
gpm	gallons per minute
GMP	Groundwater Management Permit
GMZ	Groundwater Management Zone
Golder	Golder Associates, Inc.
GZA	Goldberg-Zoino & Associates, Inc.
HMM	HMM Associates, Inc.
ICLs	Interim Cleanup Levels
LUI	lower upper interbedded
MCLs	Maximum Contaminant Levels
MCLGs	Maximum Contaminant Level Goals
MEK	methyl ethyl ketone
mg/Kg	milligram per kilogram

mg/L	milligram per Liter, equivalent to parts per million (ppm) for aqueous samples
MIBK	methyl iso-butyl ketone (2-butanone)
MOM	management of migration, remedial alternative
MNA	Monitored Natural Attenuation
mS/cm	milli-Siemen per centimeter
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
NHCAR	New Hampshire Code of Administrative Rules
NHDES	New Hampshire Department of Environmental Services
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
PCE	tetrachloroethene
PDI	Pre-Design Investigation
POTW	Publicly Owned Treatment Works
PQL	Practical Quantitation Limit
psig	pounds per square inch, gauge
RAOs	Remedial Action Objectives
RAR	relevant and appropriate requirement, division of ARAR
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RFFS	Revised Focused Feasibility Study
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SC	source control, remedial alternative
SC-FFS	Source Control Focused Feasibility Study
scfm	standard cubic foot per minute
SDWA	Safe Drinking Water Act
SEA	SEA Consultants, Inc.
Site	Dover Municipal Landfill Superfund Site
SVI	soil vapor intrusion
SVOCs	semi-volatile organic compounds
SWQSs	Surface Water Quality Standards, NHDES
TBCs	To be Considered
TCA	1,1,1-trichloroethane
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
THF	tetrahydrofuran
TOC	total organic carbon
TZD	Treatment Zone Demonstration
US	upper sand
USEPA	United States Environmental Protection Agency

UUI	upper upper interbedded
µg/kg	microgram per kilogram
µg/L	microgram per Liter, equivalent to parts per billion (ppb) for aqueous samples
VC	vinyl chloride
VOCs	volatile organic compounds
Wehran	Wehran Engineers and Scientists
XDD	Xpert Design & Diagnostics, L.L.C.

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EXECUTIVE SUMMARY

The 2004 Amended Record of Decision (AROD) selected a Source Control (SC) remedy for the Dover Municipal Landfill Superfund Site in Dover, New Hampshire (the Landfill) that employed an air sparging trench located at the downgradient perimeter of the Landfill to intercept and treat impacted ground water. In cooperation with United States Environmental Protection Agency (USEPA) and New Hampshire Department of Environmental Services (NHDES), the Group conducted a number of pre-design investigations (PDI) described in Section K.3 of the 2004 Amended Record of Decision (AROD). During the summer of 2007 the Group collected soil, ground water, and surface water samples and began assembling the required PDI reports.

This document presents the data relevant for designing the air-sparging trench as part of the air-sparging trench PDI report in Section 1 of this document. While the 2004 AROD provided the broad outlines of the Source Control Remedy, the Second Consent Decree (2007 CD) and its accompanying Scope of Work (2007 SOW) dictate the implementation of the Source Control Remedy, an air-sparging trench. However; information from this PDI and for the Northwest Landfill Source Area and the Southern Plume PDIs, coupled with recent information regarding the performance of interceptor trenches indicated that other remedial options, operating on the same principle, may meet the Performance Standards for the Source Control Remedy and avoid technical hurdles in implementation and operation of an air-sparging trench.

Therefore, after discussion with USEPA and NHDES it was agreed to evaluate these options prior to moving forward with design of the air-sparging trench. The Source Control Focused Feasibility Study (SC-FFS) presented in this document compares the air sparging trench (SC-A) with an alternative (SC-Ex) that involves the use of an extraction well system located at the downgradient toe of the Landfill to intercept and transfer impacted ground water to off-site treatment at the City of Dover Publicly Owned Treatment Works (Dover POTW). This evaluation was prompted by and premised, in part, upon evaluation of new information obtained regarding:

- Southern Plume pre-design investigation (PDI) results indicating that the center of mass is located relatively close to the southwest corner of the Landfill footprint;
- data from the Northwest Landfill PDI indicating an area of relatively high concentrations of target constituents of concern (COCs) in northwestern corner of the Landfill; and

- data from the Air Sparging Trench PDI indicating the absence of other localized areas of significant COC impacts within the Landfill footprint and at its downgradient perimeter.

Fundamentally, Alternative SC-Ex involves replacing the air sparging trench with a network of extraction wells. The 2004 AROD remedy (SC-A) included a separate ground water recirculation system installed at the southwest corner of the Landfill to address concentrations of tetrahydrofuran (THF) that exceed the treatment capacity of the trench. In Alternative SC-Ex, this system will be eliminated because the THF concentrations are treatable by the Dover POTW. In addition, the use of hydraulic flow barriers to ensure capture in the trench will not be necessary in Alternative SC-Ex because of the flexibility of extraction well location and operation to ensure capture. Aside from these changes, the technical elements of Alternative SC-Ex are functionally equivalent to those of SC-A. Alternative SC-Ex was determined to be:

- simpler and faster to install;

- pose fewer uncertainties with respect to long-term operation and maintenance (O&M); and

- cost significantly less than SC-A.

(It should be noted that changes to the Management of Migration (MOM) elements of the 2004 AROD remedy were not proposed.)

2004 AROD SOURCE CONTROL REMEDY

The SC elements of the 2004 AROD remedy (Alternative SC-A) included (Part I, Section E, pages ii through iv, 2004 AROD):

- interception and treatment of impacted ground water using an air sparging trench located at the downgradient toe of the Landfill;

- maintenance of the existing vegetative cover over the entire Landfill to mobilize and convey COCs to the air sparging trench at the perimeter;

- removal of arsenic-impacted sediment from the perimeter ditch and drainage swale to meet the cleanup level (Part II, Section K.4[a][2], pages 74 through 75, 2004 AROD) of 50 milligrams per kilogram (mg/Kg);

- direct removal or pumping and treating of ground water with COC concentrations that may exceed the treatment capacity of the trench (e.g., in the area of the southwest corner of the Landfill where THF is present in ground water); and

- identifying and addressing areas of high COC contamination (hotspots) identified within the Landfill.

The 2004 AROD established two contingent SC remedies. The first involved designing the air injection systems installed in the air sparging trench so that they could be converted to be used as extraction systems in the event that in-trench treatment was unable to attain Performance Standards (Part II, Section K.1, pages 66 and 67, 2004 AROD). The second contingent remedy involved abandonment of the air sparging trench approach and construction of the remedy selected in the 1991 Record of Decision (ROD), which included an impermeable cap and a ground water extraction system at the downgradient toe of the Landfill with transfer of the intercepted water and leachate to the Dover POTW for treatment (Part II, Section K.4.b[1], pages 75 and 76, 2004 AROD). The merits of the ground water extraction at the Landfill toe and treatment at the Dover POTW were thoroughly evaluated and established through the 100 percent design process for the 1991 ROD remedy, completed in 1996. (Hotspot identification and removal or treatment and removal of arsenic-impacted sediment were also included in the 1991 ROD remedy.)

ALTERNATIVE SOURCE CONTROL REMEDY

The proposed revised SC remedy (Alternative SC-Ex) would include:

- interception of impacted ground water at the downgradient toe of the Landfill (including THF impacts at the southwest corner of the Landfill) using a network of extraction wells;
- transfer of the intercepted water and leachate to the Dover POTW for treatment;
- removal from the Landfill perimeter ditch and drainage swale of sediment containing arsenic at concentrations above the 50 mg/Kg cleanup level established in the 2004 AROD;
- maintenance of the existing vegetative soil cap on the Landfill to ensure flushing of COCs to the capture system for off-treatment; and
- removal or treatment of localized hotspots of COC contamination identified within the Landfill.

NEW INFORMATION

Newly obtained information from the recently completed PDI activities that influenced this proposed change to the SC remedy included:

- identification of the Southern Plume center of mass at a location relatively close to the southwest corner of the Landfill;
- confirmation of the presence of a hotspot of relatively high COC concentrations in ground water in the northwest portion of the Landfill that serves as a source of surface water VOC impacts in the northern portion of the perimeter ditch that ultimately discharges to the drainage swale and the Cocheco River;

- the absence of other COC hotspots within the Landfill; and

- the presence of relatively dilute COC concentrations along and upgradient of most of the Landfill toe.

Operation of an extraction system to address the Southern Plume will add uncertainty with regard to potential hydraulic interferences with the function of the sparging trench and the local THF recirculation system. The Southern Plume PDI results obtained to date indicated that the Southern Plume center of mass is located relatively close to the southwest corner of the Landfill. Because of the plume center of mass location, ground water extraction operations are likely to be sited relatively close to the western end of the air sparging trench with the resulting potential for hydraulic interference with the SC remedy function. In addition, the results of the Northwest Landfill and Trench PDIs obtained to date indicate that the Northwest Landfill hotspot may be the source of the THF impacts observed at the southwest corner of the Landfill. Accordingly, recirculation of ground water back into the Landfill footprint upgradient of the southwest toe may disperse the THF impact, complicating its treatment. In any event, recirculation will likely interfere with or reduce the efficiency of flushing to and capture by the trench of COCs present in the Northwest Landfill hotspot area.

RATIONALE FOR SOURCE CONTROL REMEDY CHANGE

The 2004 AROD and draft Statement of Work issued pursuant to the AROD identified several issues of uncertainty regarding the construction and operation of the air sparging trench component of Alternative SC-A that were sufficient to require several specific mitigation measures that included:

- construction and operational optimization of one segment of the air sparging trench prior to construction of the other segments, extending the overall schedule to design and implement the remedy at full scale;

- design requirements that would allow conversion of the air injection system to a ground water extraction system;

- design requirements for trench backfill cleaning and replacement to address possible clogging by inorganic precipitates; and

- specification of a contingent remedy involving construction of an impermeable cap and leachate control system, a remedy described in the AROD as "less protective" than Alternative SC-A because the impermeable cap does not facilitate reduction of COC concentrations to protective levels.

The uncertainties identified regarding the leachate control elements of Alternative SC-A included:

- the constructability of the trench with regard to the reliability and quality of the air sparging system at depth, particularly in the area of the eastern corner of the Landfill where the depth to the Marine Clay layer is the greatest;

- the treatability of THF in the area of the southwest corner of the Landfill;

- the adequacy of residence time in the trench segment at the northeast corner of the Landfill to attain treatment Performance Standards for target volatile organic compounds (VOCs) due to higher ground water flow rates;

- reliably demonstrating trench performance, necessitating a more dense and complex monitoring network, and associated higher monitoring costs;

- the potential for clogging of the trench backfill or the interface between the native aquifer material and the trench backfill by inorganic solids and possible biological growth during active operation of trench; and

- the long-term stability of precipitated arsenic after active operation of the air sparging trench ends with potentially high costs for treatment or removal if the arsenic proves to be unstable.

Alternative SC-Ex eliminates the uncertainties associated with design and construction of the air sparging trench in Alternative SC-A. It provides:

- permanent, effective treatment of all identified COCs, including THF and arsenic, both of which require additional treatment systems or contingencies in Alternative SC-A;

- simpler technology elements to design, reliably construct at depth, and operate;

- efficient and cost-effective coordination with the Southern Plume ground water extraction and treatment remedy;

- efficient and cost-effective treatment of THF in the area of the southwest corner of the Landfill; and

- more flexible, cost-effective treatment of the relatively dilute COC concentrations located along and upgradient of the majority of the Landfill toe.

Alternative SC-A involves construction of 11 separate trench segments, each with its own set of air blowers and pressurized injection points. In addition, it includes a THF extraction, aboveground treatment, and re-injection system with multiple pieces of associated mechanical equipment. Alternative SC-Ex employs a single technology with which there is substantial experience and that is substantially less mechanically complex, employing a set of ground water pumps that are readily available and easily and quickly replaced. With fewer and simpler mechanical elements, alternative SC-Ex is simpler and less costly to maintain with less potential for mechanical breakdowns that will compromise its effectiveness. The POTW treatment process consists of a series of processes to treat municipal and pre-treated industrial wastes. Constituents of concern (COCs) at the Landfill will be treated by different processes. Aromatic and aliphatic VOCs will be degraded and attenuated by volatilization and aerobic biodegradation. THF is also amenable to aerobic biodegradation. Arsenic will be oxidized and precipitated in settling and solids removal processes, and will ultimately be contained at residual concentrations in the POTW sludge. Constituents in the waste stream will ultimately be degraded, attenuated, or removed in the POTW sludge.

It is estimated that bringing the full air sparging trench to an operational and functional status will require a substantial period of time, currently projected to be October 2010. This lengthy schedule is necessitated by the AROD requirements for pilot testing and optimizing a single trench segment before proceeding with design and construction of the other segments. In contrast, Alternative SC-Ex is far simpler to design and construct and is estimated to be completed within six months to one year of a decision to use it, depending upon regulatory agency approval time frames and coordination with weather conditions favorable for construction, accelerating full-scale implementation of SC by approximately 2 years.

Alternative SC-A is estimated to cost $22.5 million to construct and operate for 30 years. In addition to these costs, there are significant potential additional costs that might be incurred in the event that precipitated arsenic requires removal ($915,000 for one trench segment). In contrast, Alternatives SC-Ex is estimated to cost $8.8 million to construct and operate for 30 years, substantially less than Alternative SC-A. Given the relatively dilute concentrations of COCs along and upgradient of approximately three-quarters of the downgradient Landfill toe, Alternative SC-Ex is more cost-effective than Alternative SC-A for the COC mass that will be removed and treated.

CONCLUSION

As described in the preceding paragraphs, new information obtained from recently completed PDI activities prompted evaluation of a revised SC component to the 2004 AROD remedy. The revised component, Alternative SC-Ex, will:

- provide permanent, effective treatment at the POTW of all identified COCs without the need for complex contingency measures;
- employ simpler technology elements to design, construct, and operate;
- coordinate efficiently and cost-effectively with MOM and hotspot remedies;
- be constructed and reach full operational status more than two years sooner than the 2004 AROD SC remedy; and

- cost significantly less to implement and operate than the SC components of the 2004 AROD remedy with far less uncertainty regarding effectiveness.

SOURCE CONTROL FOCUSED FEASIBILITY STUDY
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1.0 INTRODUCTION

1.1 REPORT ORGANIZATION

The SC-FFS is organized into the following sections:

- Section 1.0 presents a summary description of characteristics, history, and current conditions at the Dover Municipal Landfill Superfund Site relevant to this SC-FFS;
- Section 2.0 updates the risk characterization for the Site;
- Section 3.0 describes the applicable or relevant and appropriate requirements (ARARs) for the potential SC remedies for the Site;
- Section 4.0 describes the potential SC remedies for the Site including the No Action Alternative, the 2004 AROD SC Remedy (SC-A), and the Alternative Source (SC-Ex) Control Remedy; and
- Section 5.0 presents a detailed analysis and comparison of the potential remedies for the Site.

The report also includes a series of appendices containing supporting information and documentation.

- Appendix A includes documentation of institutional controls currently in place at the Site and figures illustrating certain features of the Site.
- Appendix B presents ground water and surface water quality data from the Environmental Monitoring Program (EMP).
- Appendix C presents selected figures from completed PDI reports; and
- Appendix D is Technical Memorandum prepared by Xpert Design & Diagnostics, L.L.C. (XDD), dated February 13, 2009, related to Ground Water Extraction Modeling Simulations; and

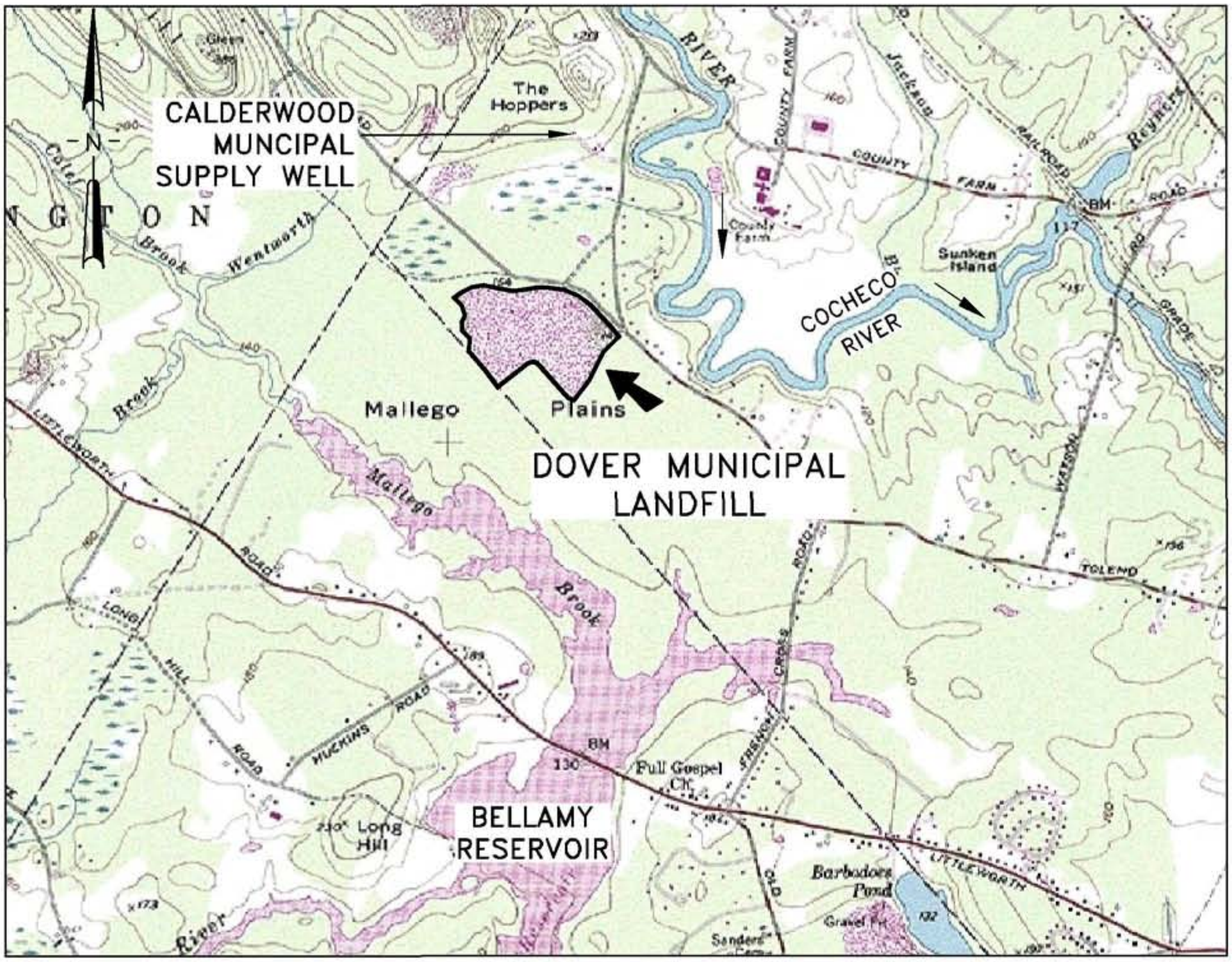
- Appendix E is a Response to Conditions and an Addendum to the response prepared upon approval of this SC-FFS, dated January 23, 2009 and February 20, 2009, respectively.

For this report, the area within the footprint of the waste material is referred to as the "Landfill" (Figure 3-1 of the 1995 PDI report indicates the limits of refuse at the Landfill). The area surrounding the Landfill, extending east to the Cocheco River, south and west to the Bellamy Reservoir, and slightly north of Tolend Road is referred to as the "Site." Figure 1-1 illustrates the location of the Landfill with respect to regional geographic features, including among other features, "The Hoppers" wetland and the Calderwood municipal well location.

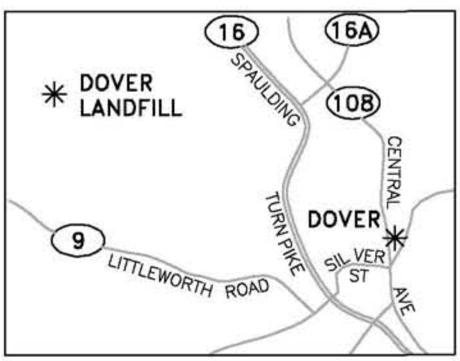
1.2 BACKGROUND

The Landfill, located to the west of Tolend Road in the west corner of the City of Dover, operated from approximately 1960 to 1979. The unlined Landfill accepted both domestic and industrial waste material from the surrounding community. Early operation practices reportedly included emptying drums of liquid waste into pits excavated to the water table and burning the waste prior to disposal (summary of Landfill operator depositions in Appendix O of the 2004 Revised Focused Feasibility Study [RFFS]). Waste disposal initially occurred in the eastern portion of the Landfill and progressed westward until the current areal extent of the Landfill was reached (approximately 47 acres). The thickness of the waste material is variable and generally increases from the east to the west, with a maximum thickness of approximately 24 feet in the west-central portion of the Landfill (Figure 3-1 of the 1995 PDI report illustrates the limits and relative thicknesses of waste material within the Landfill). Initial Landfill closure activities were completed in 1980 and consisted of placing clean fill over the existing Landfill surface. In the early 1980s, additional closure activities were undertaken and included the excavation of a ditch along the perimeter of the north, west, and south borders of the Landfill to collect surface water runoff and intercept shallow ground water flow. Features of the Site and surrounding area are shown on Figures 1-1 and 1-2.

The Site was placed on the United States Environmental Protection Agency's (USEPA's) National Priority List (NPL) on September 8, 1983. COCs at the Site include VOCs and



SITE AREA PLAN



LOCUS MAP
NOT TO SCALE

DRAFT

0 1/2 MILE 1 MILE
APPROX. SCALE IN FEET

CONTOUR INTERVAL 20 FEET

REFERENCE: TAKEN FROM USGS MAP "DOVER WEST, NH NW/4 15' QUADRANGLE, REVISED 1993.

CLIENT: DOVER GROUP			
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE			
TITLE: SITE LOCUS			
DESIGNED: CAB	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW
SCALE: AS NOTED	DATE: 12/12/07	FILE NO.: 2009-LOCUS	PROJECT NO.: 2009-007

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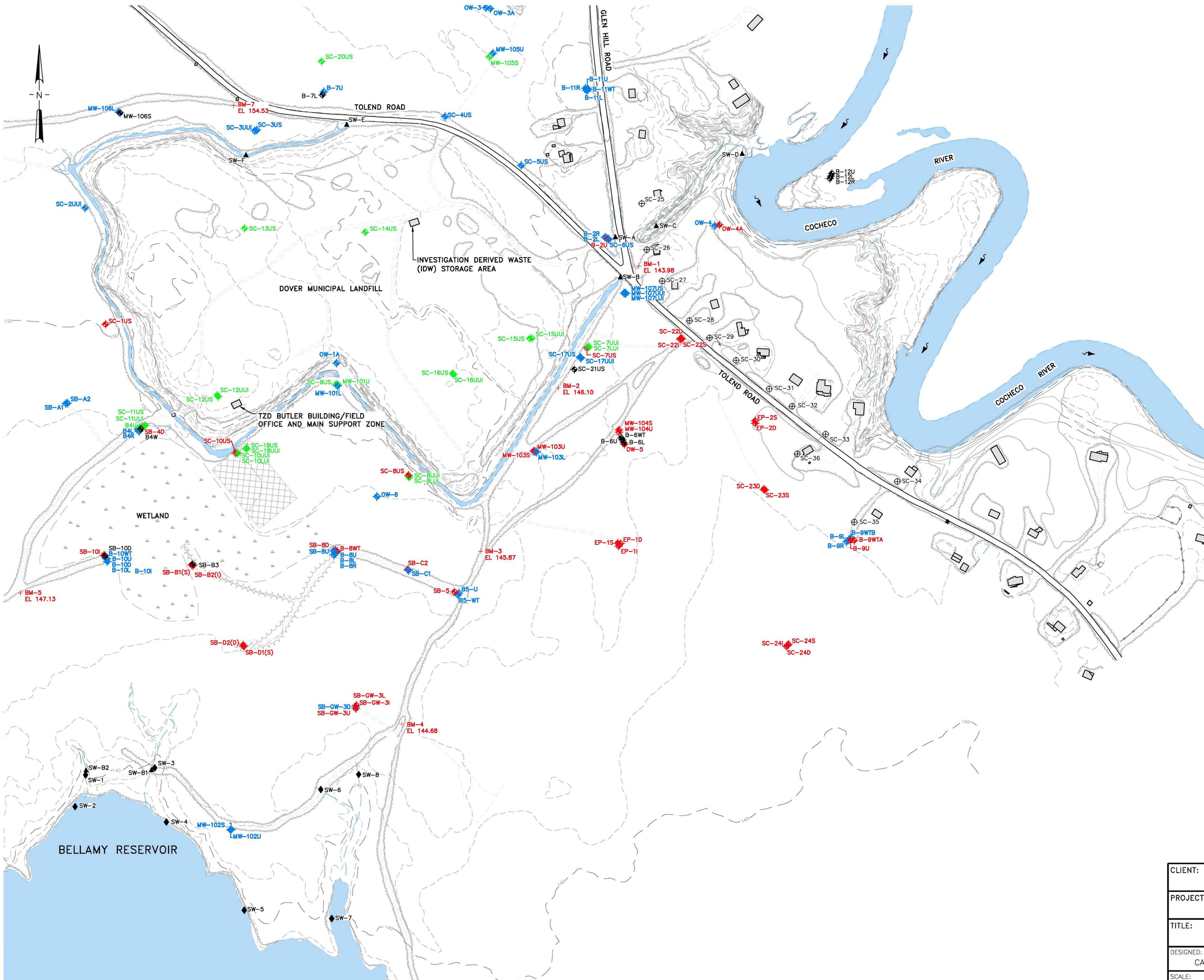
FIGURE NO.: 1 — 1

PLOT DATE: 2-12-08
FILE: M:\Projects\Active Projects\2009-Dover Landfill\FIGURES-DOVER\2009-LOCUS.dwg



LEGEND

SC-7US	EMP WELL SAMPLING LOCATION AND DESIGNATION
SC-7UUI	ADDITIONAL WELL SAMPLING LOCATION AND DESIGNATION (DECEMBER 1995 TO PRESENT)
MW-17US	WELL LOCATIONS WHERE EMP WATER LEVELS ARE OBTAINED (IE, EMP SAMPLING IS NOT PERFORMED)
OW-2	WELL LOCATIONS WHERE WATER LEVELS ARE NOT OBTAINED AND SAMPLING IS NOT PERFORMED
SW-A	EMP SURFACE WATER SAMPLING LOCATION
SC-30	SENTINEL WELL SAMPLING LOCATION AND DESIGNATION
SW-3	SURFACE WATER GAUGING STATION
150	EXISTING TOPOGRAPHIC CONTOUR
	PAVED ROAD
	UNPAVED ROAD OR DRIVE

DRAFT

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.

2. MONITORING WELL LOCATIONS UPDATED IN NOVEMBER 2007, BASED UPON COMPREHENSIVE SITE SURVEY PERFORMED BY VERMONT SURVEY AND ENGINEERING, INC. OF MONTPELIER, VERMONT.

3. LOCATION OF SURFACE WATER SAMPLING STATION SW-8 IS APPROXIMATE.

CLIENT: DOVER GROUP				GeoInsight Practical in Nature
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE				
TITLE: SITE PLAN				
DESIGNED: CAB	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW	
SCALE: 1" = 200'	DATE: 1/30/08	FILE NO.: 2009D220	PROJECT NO.: 2009-007	FIGURE NO.: 1-2

arsenic. A Remedial Investigation (RI) was completed by Goldberg-Zoino & Associates, Inc. (GZA) and Wehran Engineers and Scientists (Wehran) in 1988 based upon the results of sampling activities completed during 1985 and 1986. A Field Elements Study (FES) was completed by HMM Associates, Inc. (HMM) in 1990 based upon the results of sampling activities completed during 1989. The FES was performed to address certain technical issues that were not fully evaluated in the RI. The original Feasibility Study (FS) was completed by HMM in February 1991.

Based upon the data presented in the RI, 1991 FS and FES, the original ROD was issued by the USEPA on September 10, 1991, and a Consent Decree for Remedial Design/Remedial Action between the USEPA and the Group was finalized on August 7, 1992. The 1991 FS included a detailed evaluation of the following four SC alternatives:

Alternative	Description
SC-1	No-Action with Long-Term Monitoring.
SC-2	Limited Action with Long-Term Monitoring/Access Restriction/Institutional Controls/Alternative Water Supply.
SC-5	Re-Contouring of Landfill/Multi-Layer Cap/Slurry Wall/Ground Water Recovery System/Ground Water Treatment/Discharge to Cocheco River/Geotextile Cover in Drainage Swale (SC-5A - Alternative SC-5 with Discharge to the Dover POTW).
SC-7	Re-Contouring of Landfill/Multi-Layer Cap/Interceptor Trench/Landfill Extraction Wells/Ground Water Treatment/Discharge to Cocheco River/Pre-Design Grid Sampling/Selected Sediment Excavation/Sediment Consolidation in Landfill (SC-7A - Alternative SC-7 with discharge to the Dover POTW).

The source control remedy selected in the 1991 ROD (Alternative SC-7/7A) included removal and consolidation of arsenic-impacted sediments from the drainage swale between the Landfill and the Cocheco River, installation of a cap on the Landfill meeting Resource

Conservation and Recovery Act (RCRA) Subtitle C standards, and collection and on- or off-site treatment of COC-impacted ground water (leachate).

Since the 1991 ROD was issued, detailed investigation activities were completed during the Southern Plume Pre-Design Investigation (SEA Consultants, Inc. [SEA], 1994), 1995 PDI (Golder Associates, Inc. [Golder], 1995), and associated EMP (Golder, 1993 to present). Initial focused investigation activities completed after the 1991 ROD was issued included the Trench and Swale Characterization (GeoInsight, Inc. [GeoInsight], 1998) and the Draft Final Bioremediation Pilot Assessment (Envirogen, Inc. [Envirogen] and XDD, 2001).

In 1994, while the design of the 1991 ROD remedy was in progress, the Group reviewed innovative remedial methods to identify potential approaches that could offer a more cost-effective, permanent treatment of the target COCs at the Site than the long-term containment remedy identified in the 1991 ROD.

In May 1996, GeoInsight completed a focused feasibility study (FFS) for the Site. The objective of the FFS was to compare the selected 1991 ROD remedy to two *in situ* alternatives that appeared to be applicable based upon Site-specific technical data and recent advances in remedial technologies since the 1991 ROD was issued. The *in situ* alternatives evaluated in the FFS included a biowall (aerobic treatment trench) and an *in situ* treatment zone.

Based upon the results of a treatability study (Envirogen, 1995), field sparging study (Envirogen, 1996), the FFS (GeoInsight, 1996), and discussions with the agencies, the USEPA and the New Hampshire Department of Environmental Services (NHDES) approved implementation of a bioremediation treatment zone pilot study, a field demonstration of an *in situ* biodegradation remedy. The bioremediation pilot was performed by the Group between 1996 and 2001 under an Administrative Order by Consent signed in 1997. It included a Treatment Zone Demonstration (TZD), which employed *in situ* sequential anaerobic and aerobic enhanced biodegradation. The results of the bioremediation pilot project were described in the Draft Final Bioremediation Pilot Assessment (Envirogen and XDD, 2001), which was reviewed, but not approved, by the NHDES and USEPA. The evaluation of that report by the NHDES is described in a letter dated April 23, 2002 (included in Appendix A of the USEPA's January 30, 2004 RFFS Addendum).

Based upon discussions with the USEPA and NHDES, it was agreed that Site-specific information derived from previous studies would form the basis for an evaluation of the Landfill bioreactor/aerobic treatment trench remedy compared to the 1991 ROD source control remedy. To complete the required evaluation of the alternative remedy, the 1996 FFS was revised, and the results were presented in the January 30, 2004, *Draft* RFFS (GeoInsight, 2004).

Prior to evaluating remedial alternatives, the previous risk characterization was updated to account for current Site conditions and changes in toxicological information and assumptions used in risk assessment. The results of then-current EMP monitoring events (August 2000, December 2000, and Summer 2001) were used to evaluate whether conditions at the Site and the associated risk to human health and the environment had changed significantly since the 1991 FS was completed. The results of the risk characterization update were used to assist in evaluating the remedial action objectives that were originally developed during the 1991 FS and for revising these objectives, as warranted. Based upon the revised remedial action objectives, the 2004 RFFS included a detailed evaluation of four remedial alternatives:

- the No Action Alternative (designated SC-1 and MOM-1);
- the 1991 ROD Remedy (designated SC-7/7A and MOM-2/4);
- the Alternative Remedy (designated SC-A and MOM-2); and
- the Mixed Alternative Remedy (designated SC-A and MOM-2/4).

Section 2.0 of the 2004 RFFS summarized the Risk Characterization update. Section 3.0 of the 2004 RFFS summarized the revision of remedial action objectives, and Section 5.0 of the 2004 RFFS summarized the detailed analysis of remedial action alternatives.

Based upon the 2004 RFFS as qualified by EPA's RFFS Addendum and discussion with the agencies, the 2004 AROD was executed in 2007 and identified the Mixed Alternative Remedy (SC-A and MOM-2/4) as the selected remedial approach for the Site. The Mixed Alternative Remedy was described on page 42 of the 2004 AROD as:

<u>Proposed Mixed Alternative</u>

1. SC-A: Source Control, as in the Proposed Alternative, the Landfill remains uncapped with a soil cover in place and an air sparging trench captures or degrades all contaminants with a contingency for capping and dewatering.

2. MOM-2/4: Management of Migration, same as 1991 ROD MOM.

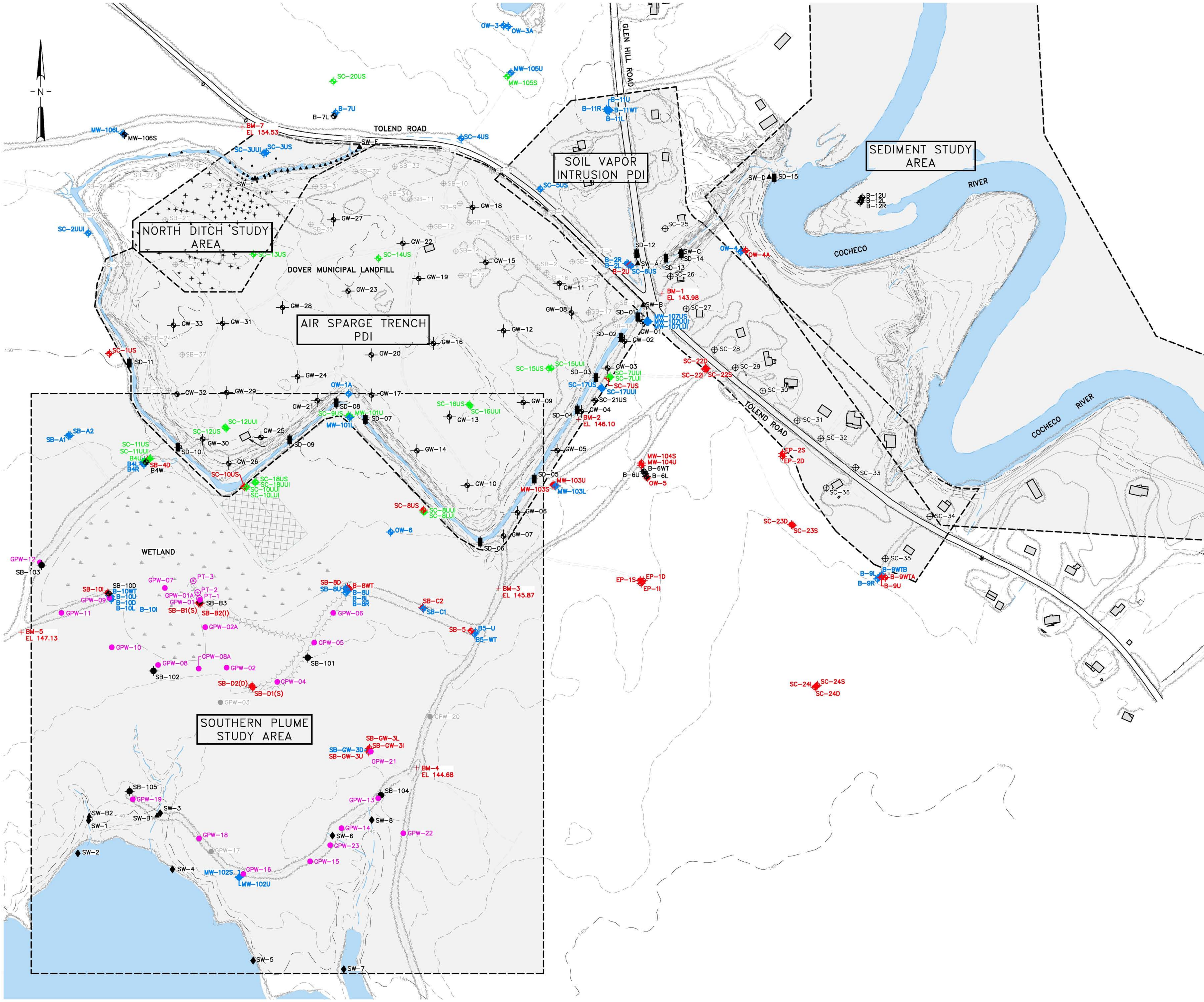
The Mixed Alternative Remedy (SC-A) is described in Section 4.5 of this SC-FFS.

The 2004 AROD also required that several PDIs be performed to further evaluate conditions in certain areas of the Landfill and Site to support design of the selected remedy. A summary of PDIs and objectives completed since the 2004 AROD is included in Section 1.4.6. Figure 1-3 illustrates the locations of PDI study areas. Pertinent results of the PDIs related to the SC portion of the selected remedy are presented in this SC-FFS report.

1.3 SOURCE CONTROL FOCUSED FEASIBILITY STUDY

In the 2004 AROD, several uncertainties were identified regarding construction and operation of the air sparging and aerobic treatment trench that were to be further evaluated in specific PDIs. Pursuant to the 2004 AROD, several PDIs were completed. Based upon new information obtained from these investigations, it was evident that reevaluation of the trench element of the SC remedy was warranted.

The 2004 AROD presented an approach for MOM components in each remedial alternative evaluated. This report does not discuss the MOM elements of the alternatives; the MOM elements of the 2004 AROD remedy are to remain as presented in the 2004 AROD, subject to the final design based upon the results of the PDI investigations. Also, certain primary SC



LEGEND

SC-7US	EMP WELL SAMPLING LOCATION AND DESIGNATION
SC-7UUI	ADDITIONAL WELL SAMPLING LOCATION AND DESIGNATION (DECEMBER 1995 TO PRESENT)
MW-17US	WELL LOCATIONS WHERE EMP WATER LEVELS ARE OBTAINED (IE, EMP SAMPLING IS NOT PERFORMED)
OW-2	WELL LOCATIONS WHERE WATER LEVELS ARE NOT OBTAINED AND SAMPLING IS NOT PERFORMED
SW-A	EMP SURFACE WATER SAMPLING LOCATION
SC-30	SENTINEL WELL LOCATION AND DESIGNATION
SB-2	SOIL BORING LOCATION AND DESIGNATION
650-60	NORTHERN PLUME – SOIL BORING
SD-04	SEDIMENT SAMPLE LOCATION AND SAMPLE ID, XDD, JULY 2007
GW-04	GEOPROBE BORING LOCATION
150	EXISTING TOPOGRAPHIC CONTOUR
	PAVED ROAD
	UNPAVED ROAD OR DRIVE

SOUTHERN PLUME PDI LOCATIONS:

GPW-21	GEOPROBE BORING LOCATION – WATER SAMPLES OBTAINED (DECEMBER 2006)
GPW-20	PROPOSED PDI GEOPROBE BORING LOCATION – NOT PERFORMED
SB	SOIL BORING LOCATION (GEOINSIGHT 2006)
SW-3	SURFACE WATER GAUGING STATION

NORTH DITCH PDI SAMPLE LOCATIONS:

- SURFACE WATER SAMPLING LOCATION
- PIEZOMETER
- DISCRETE WATER SAMPLING LOCATION

DRAFT

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.
2. MONITORING WELL LOCATIONS UPDATED IN NOVEMBER 2007, BASED UPON COMPREHENSIVE SITE SURVEY PERFORMED BY VERMONT SURVEY AND ENGINEERING, INC. OF MONTPELIER, VERMONT.
3. LOCATION OF SURFACE WATER SAMPLING STATION SW-8 IS APPROXIMATE.

0 200 400
APPROX. SCALE IN FEET

CLIENT: DOVER GROUP				GeoInsight Practical in Nature
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE				
TITLE: DOVER MUNICIPAL LANDFILL – STUDY AREAS				
DESIGNED: JT	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW	
SCALE: 1" = 200'	DATE: 2/1/08	FILE NO.: 2009D210	PROJECT NO.: 2009-007	FIGURE NO.: 1-3

elements of the 2004 AROD will be implemented without further re-analysis including:

- using the Landfill and ground water beneath as a bioreactor;
- maintaining the permeable protective cover to prevent contact with waste materials and allow infiltration;
- eliminating localized sources areas within the Landfill through "excavation or other ex-situ techniques "(2004 AROD, Section K.1, page 65); and
- removing arsenic-impacted sediment from the perimeter ditch and swale for off-site disposal, and backfilling the perimeter ditch.

Elements of the selected SC remedy that are reevaluated in this report include:

- installing a downgradient air sparging and aerobic treatment trench;
- installing a vertical hydraulic barrier along Tolend Road to divert ground water flow toward the air sparging trench; and
- extracting and treating ground water from the southwest corner of the Landfill to address elevated THF concentrations in this area that "may overwhelm the treatment capacity of the air sparging trench" (2004 AROD, Section K.1, page 65).

As previously discussed, the findings of several PDIs provided "new information" that changed the understanding of conditions in the interior of the Landfill, including the identification of a VOC "hotspot" in ground water in the northwest portion of the Landfill. This SC-FFS report presents findings from PDIs that indicate that ground water recovery along the toe of the Landfill offers more flexibility in design, is more cost -effective, and provides greater certainty to achieve remedial action objectives (RAOs). The SC-FFS was performed in general accordance with USEPA guidance documents summarized on pages 1 through 6 of the 2004 RFFS. In this report, an alternative SC Alternative Remedy (designated SC-Ex) is presented and evaluated against the 2004 AROD SC Remedy (designated SC-A) using the nine evaluation criteria identified in the USEPA's FS guidance.

The 2004 AROD included a specific contingency remedy (Section K.4[b], page 75 of AROD) for the SC air sparing trench element that would be implemented if the trench failed certain performance criteria after operational optimization. The contingent remedy is the 1991 ROD remedy consisting of capping the Landfill with a RCRA C cap and extracting contaminated ground water at the Landfill boundary for off-site treatment at the Dover POTW. Along with the other remedy elements, ground water extraction at the Landfill toe and treatment at the Dover POTW were incorporated in the 100 percent design of the 1991 ROD remedy, completed in 1996. Alternative SC-Ex is fundamentally similar to this contingent remedy with the exception of using a permeable cap to ensure that COCs are flushed from the Landfill to capture by the ground water extraction system and permanent treatment at the Dover POTW.

1.4 DESCRIPTION OF CURRENT SITE CONDITIONS

1.4.1 Overview

This section summarizes current uses of the Site and surrounding properties and conditions in environmental media at the Site, including ground water, surface water, sediment, and air. Specifically, information relevant to comparison of the SC remedies (i.e., the objective of this report) is re-iterated and updated to reflect new information obtained since the 2004 RFFS was prepared. Information that is not immediately relevant to this discussion is summarized in previous reports and is referenced in this report, as appropriate.

The summary of Site information and data presented in the 2004 RFFS was based primarily upon evaluations completed during the RI (GZA and Wehran, 1988) and FES (HMM, 1990) that were presented in the 1991 ROD. Evaluations reported in the RI were based upon the results of activities initiated in 1979 and completed during 1985 and 1986. Evaluations completed during the FES were based upon the results of activities completed during 1989. During the time period between issue of the 1991 ROD and preparation of the 2004 RFFS, detailed investigation activities were completed during the Southern Plume PDI (SEA, 1994), PDI (Golder, 1994), Trench-Swale Characterization (GeoInsight, 1998), PDI EMP (1993 to present), and the bioremediation pilot project (1996 to 2001). These characterization activities provided additional information regarding hydrogeologic and environmental conditions at the Site. In particular, PDI activities provided additional information regarding the stratigraphy and hydraulic conditions within the upper hydrostratigraphic unit (the unit impacted by the Landfill), and PDI EMP data provided significant additional information regarding ground water and, in more recent years, surface water quality conditions.

Since the 2004 RFFS was prepared, several additional PDIs have been performed at the Site that provided additional information related to potential impacts on specific receptors (i.e., Cocheco River, Bellamy Reservoir, and nearby residents) and related to the distribution of COCs within the interior of the Landfill and at the toe of the Landfill (see Figure 1-3 for study area locations). These PDI activities included:

- focused sediment sampling to evaluate ecotoxicity in the Cocheco River east of the Landfill (performed by GeoInsight, 2005 to 2006);
- surface water sampling, discrete ground water sampling and soil boring activities to evaluate conditions in the northwest portion of the Landfill and perimeter ditch (performed by GeoInsight, 2005 to 2006);
- discrete water sampling and soil boring activities to evaluate conditions in the area between the Landfill and the Bellamy Reservoir (performed by GeoInsight, 2006 to 2007);
- ground water sampling to evaluate conditions associated with potential vapor intrusion near residents along Tolend Road (performed by GeoInsight, 2006 to 2007); and
- discrete water sampling to evaluate conditions in the interior of the Landfill (performed by XDD, 2007).

Conditions at and in the vicinity of the Landfill with regard to land use have not changed significantly since the 2004 AROD was issued. Conditions at the Landfill and adjacent forested wetlands are virtually unchanged. Historically, the City of Dover acquired and now controls properties in the vicinity of the Landfill (Appendix A), and brush and vegetation on the Landfill surface have grown larger and more dense. Conditions in the vicinity of the

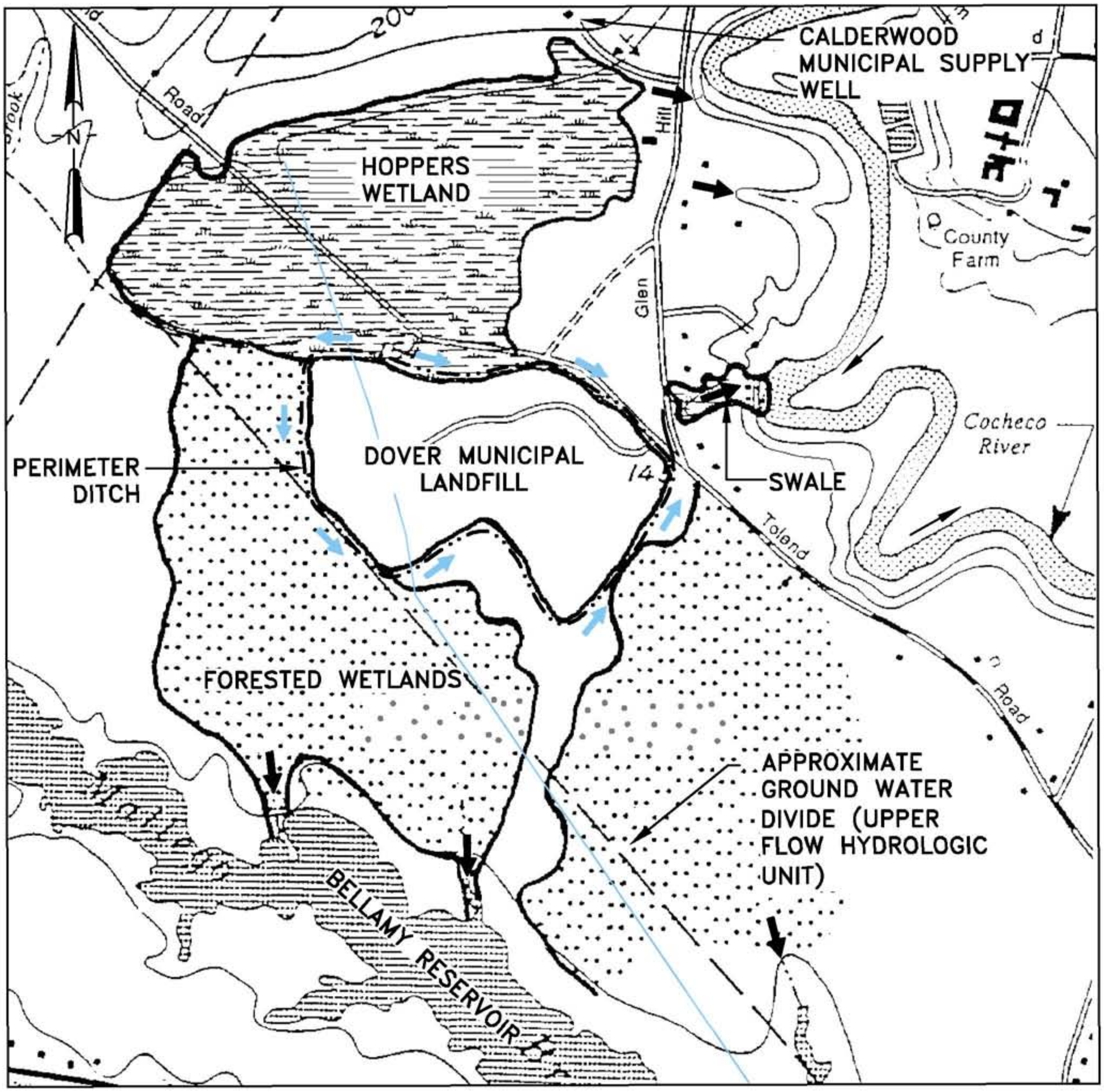
Landfill along Glen Hill and Tolend Roads are characterized by sparsely developed residential properties. With the exception of the construction of a few residential structures along Glen Hill and Tolend Roads (not immediately adjacent to the Landfill), additional development has not occurred in the Site vicinity since the 1991 ROD was issued.

The EMP is described in Section 1.4.4. Results of historical EMP monitoring have consistently identified the primary COCs detected in ground water at the Site that includes VOCs and arsenic. VOCs detected in ground water at the Site include aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylenes, collectively known as BTEX), chlorinated hydrocarbons (tetrachloroethene [PCE], trichloroethene [TCE], *cis*-1-2-dichloroethene [cDCE], vinyl chloride (VC), 1,1,1-trichloroethane [TCA], 1,1-dichloroethane [1,1-DCA], 1,1-dichloroethene [1,1-DCE], 1,2-DCA, methylene chloride, acetone, THF, 4-methyl-2-pentanone [methyl iso-butyl ketone, or MIBK], and 2-butanone [methyl ethyl ketone, or MEK]). Updated information related to ground water conditions at the Site is described further in Section 1.4.9 of this report, and tables that summarize the results of historical EMP ground water monitoring events are included in Appendix B.

Surface water samples were collected from the perimeter ditch, drainage swale, Cocheco River, and the Bellamy Reservoir during RI/FS, FES, PDI, and EMP activities (see Figures 1-4 and 1-5). Surface water conditions at the Site are described further in Section 1.4.10 of this report.

1.4.2 General Conditions

The subsections that follow provide a brief summary of the current general conditions including Landfill uses, Landfill topography and vegetation, the surrounding area, and potential receptors.



LEGEND

SURFACE WATER FLOW DIRECTION - PERIMETER DITCH

SURFACE WATER FLOW DIRECTION - WETLAND AREAS

DRAFT

0 1000' 2000'

APPROX. SCALE IN FEET

NOTES:

1. FIGURE IS BASED UPON FIGURE 2-7 OF FEBRUARY 1995 PDI REPORT.

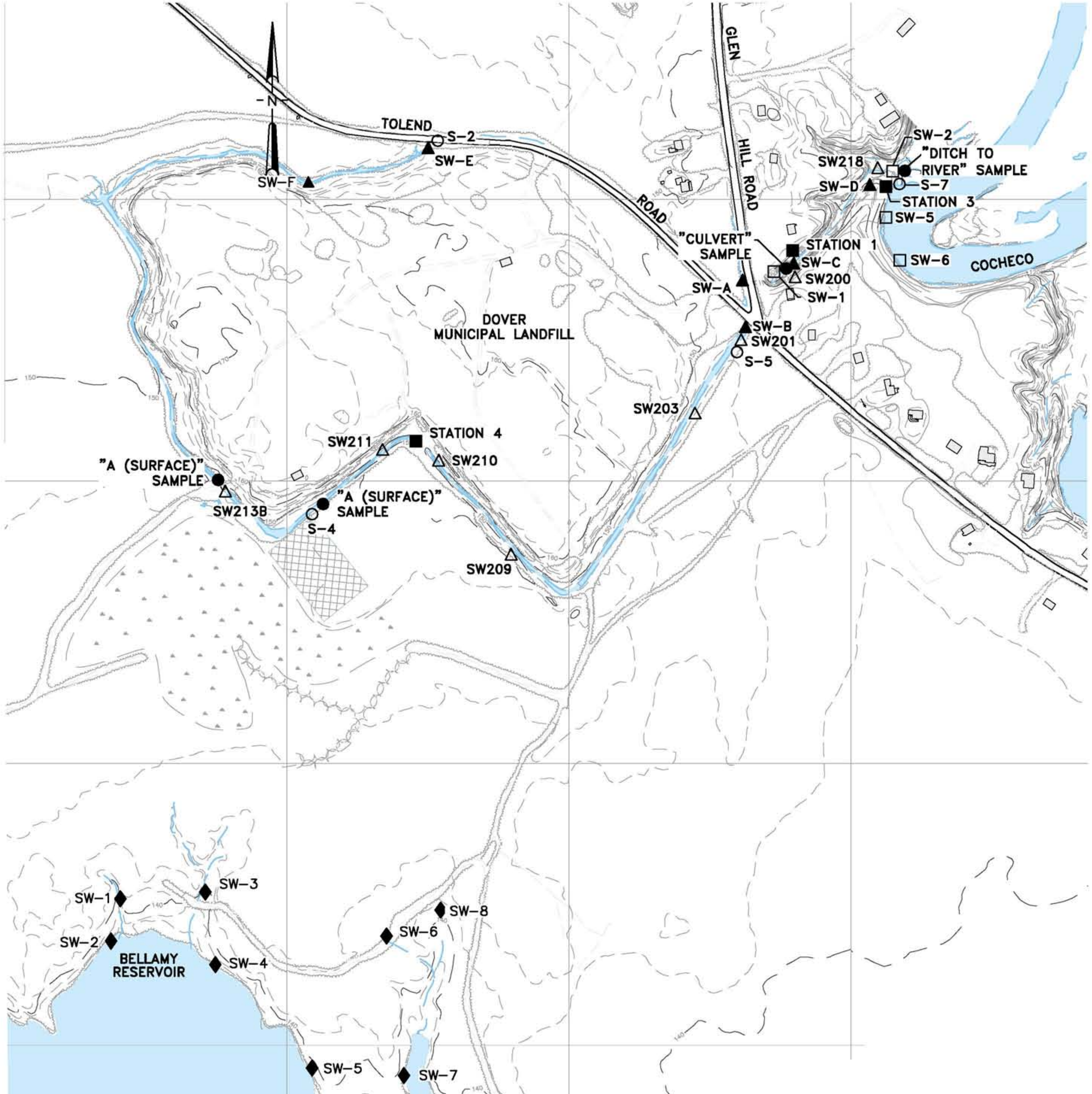
REFERENCE: BASE MAP TAKEN FROM USGS MAP 7.5 MINUTE QUADRANGLE "DOVER WEST, DATED 1956, PHOTO REVISED 1988.

CLIENT: DOVER GROUP			
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE			
TITLE: SURFACE WATER FLOW DIRECTION			
DESIGNED: CAB	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW
SCALE: AS NOTED	DATE: 1/30/08	FILE NO.: 2009d204	PROJECT NO.: 2009-005

GeoInsight
Practical in Nature

FIGURE NO.: 1-4

PLOT DATE: 2-12-08
FILE: M:\Projects\Active Projects\2009-Dover Landfill\FIGURES-DOVER\2009d204.dwg



LEGEND:

- ● SURFACE WATER SAMPLES COLLECTED IN 1981 AND 1982 BY CAMP, DRESSER AND MCKEE (CDM) (TOLEND ROAD LANDFILL SITE INVESTIGATION, CDM, JULY 1982).
- ○ SURFACE WATER SAMPLES COLLECTED IN 1985 AND 1986 BY GOLDBERG-ZIONO AND ASSOCIATES AND WEHRAN ENGINEERS AND SCIENTISTS (REMEDIAL INVESTIGATION, GOLDBERG-ZOINO AND WEHRAN, NOVEMBER 1988).
- □ SURFACE WATER SAMPLES COLLECTED IN 1989 BY HMM ASSOCIATES (FIELD ELEMENTS STUDY AND SUPPLEMENTAL RISK ASSESSMENT, HMM ASSOCIATES, MAY 18, 1990).
- ■ SURFACE WATER SAMPLES COLLECTED IN 1990 BY THE U.S. ENVIRONMENTAL PROTECTION AGENCY (DOVER MUNICIPAL LANDFILL FEASIBILITY STUDY, HMM ASSOCIATES, FEBRUARY 28, 1991).
- △ SURFACE WATER SAMPLES COLLECTED IN 1997 BY GEOINSIGHT (TRENCH AND SWALE CHARACTERIZATION REPORT, GEOINSIGHT, OCTOBER 9, 1998).
- ▲ SURFACE WATER SAMPLES COLLECTED IN 2000-2002 BY GOLDER ASSOCIATES IN CONJUNCTION WITH THE ENVIRONMENTAL MONITORING PROGRAM (EMP) (REPORTED IN VARIOUS EMP SUBMITTALS).

DRAFT

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.

2. MONITORING WELL LOCATIONS UPDATED IN NOVEMBER 2007, BASED UPON COMPREHENSIVE SITE SURVEY PERFORMED BY VERMONT SURVEY AND ENGINEERING, INC. OF MONTPELIER, VERMONT.

3. LOCATION OF SURFACE WATER SAMPLING STATION SW-8 IS APPROXIMATE.

0 400 800
APPROX. SCALE IN FEET

CLIENT: DOVER GROUP				
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE				GeoInsight Practical in Nature
TITLE: HISTORIC SURFACE WATER SAMPLE LOCATIONS				
DESIGNED: MJW	DRAWN: NMT	CHECKED: MJW	APPROVED: MJW	
SCALE: 1"=400'	DATE: 1/30/08	FILE NO.: 2009D0203	PROJECT NO.: 2009-005	FIGURE NO.: 1-5

PLOT DATE: 2-12-08
FILE: M:\Projects\Active Projects\2009-Dover Landfill\FIGURES-DOVER\2009d203.dwg

1.4.2.1 Landfill – Uses

The Landfill is currently closed and is not used by the City of Dover for either landfill purposes or for ancillary uses, such as storage. The City owns the land that is occupied by the Landfill and the adjacent woodlands (Appendix A). These properties are marked by signs indicating that hunting is not permitted on City-owned land. Notices are also posted at the border of the Landfill indicating that hazardous wastes are present.

The entrance, secured by a locked gate, is located at the northeast corner of the Landfill (Appendix A). A chain-link fence restricts access to the Landfill to the north along Tolend Road. A similar fence located to the east of the entrance along Tolend Road restricts access to woodlands and forested wetlands (including several dirt access roads) located to the southeast of the Landfill. These fences were present at the time the 1991 ROD was issued.

1.4.2.2 Landfill – Topography and Vegetation

With the exception of minor alterations, the topography and surface of the Landfill have not been changed since the 1991 ROD was issued. Based upon evaluations completed during the 1995 PDI, the approximate footprint of the Landfill is 47 acres. The top of the Landfill surface is relatively flat and slopes slightly upward to the west toward the northwest corner of the Landfill, with a total elevation change over the 2,000-foot length of the Landfill of approximately 20 feet. Along the east and north borders, the elevation of the Landfill surface is similar to that of Tolend Road (i.e., there is no defined side slope and toe to the Landfill). To the south and west, the Landfill border is defined by a side slope that reaches a maximum height (above the adjacent woodlands) of approximately 20 feet near the northwest corner of the Landfill.

The growth of vegetation on top of the Landfill and the growth of brush and trees along several of the perimeter Landfill locations, particularly along the northeast and north portions of the Landfill, reflect the greatest physical change to the Landfill since the 1991 ROD.

Poplar and birch trees are well-established in some areas. The majority of the central portion of the Landfill is covered by grasses and low brush. Photographs of the Landfill surface are included in Appendix A. Other changes to the Landfill surface are described in the items that follow.

- During PDI activities, a chain-link fence-enclosed waste materials storage area was installed in the east central portion of the Landfill. During the PDI, the area was used to store materials and waste material generated during PDI investigation activities. The fenced area is currently vacant and overgrown by vegetation.

- During the bioremediation pilot project, the dirt road that originated at the Landfill entrance and traversed the north central portion of the Landfill was upgraded by the addition of a layer of structural fill. This dirt road continues to provide access to the top of the Landfill.

- During the bioremediation pilot project, a concrete pad (the base for a vertical oxygen storage tank) and a small Butler-style building were installed near the southwest corner of the Landfill. These structures were used from 1996 to 2001 during the operation of the bioremediation pilot project. The oxygen tank was removed, and the building is currently used as a support zone for PDI activity.

- During the bioremediation pilot project, electrical power poles were installed along the dirt access road across the top of the Landfill to the southwest corner of the Landfill. The poles carry electrical lines to the Butler-style building.

- During the bioremediation pilot project, an area of approximately 200 by 300 feet was cleared of standing trees near the southwest corner of the Landfill. The area was used for the installation of sodium benzoate and oxygen injection systems for the TZD. The area is currently not used and is vegetated by brush and small trees.

- For a period of time in the late 1990s, the City of Dover used the top of the central portion of the Landfill for storing composted wastewater treatment sludge. The Landfill is no longer used to store composted sludge. Several small piles of composted sludge remain near the central portion of the Landfill. These piles have become vegetated by grass and low brush.

1.4.2.3 Surrounding Area

Conditions in the general vicinity of the Landfill have not changed since the 1991 ROD. The general population, land use, and development in the vicinity of the Landfill are consistent with conditions when the RI/FS was completed. Current (2004) data obtained from the City of Dover indicate that there are 23 residences located along Tolend and Glen Hill Road within a 0.25-mile radius of the Landfill (see map in Appendix A). The residential population associated with these properties is estimated to be approximately 50 people (although current census data are not available for these 23 homes, the current population of the Dover is 26,884, and the total number of residences is 13,052, indicating an average of two residents per dwelling on a City-wide basis).

Properties to the southeast, south, west, and northwest of the Landfill consist of undeveloped woodland and forested wetlands. Most of these properties are owned by the City of Dover and are posted for "No Hunting." The woodlands and forested wetlands extend to the south and west to the Mallego Brook and Bellamy Reservoir, which are located approximately 1,500 feet west and south of the Landfill (Figure 1-1).

Properties located on the north and south side of Tolend Road to the north and northeast of the Landfill consist of undeveloped woodland and wetlands (Appendix A). These properties include a large wetlands-bog complex located on the north side of Tolend Road that is locally referred to as "The Hoppers" (Figure 1-1).

Properties located to the northeast of the Landfill on the east and west sides of Glen Hill Road, and to the east-southeast on the north and south sides of Tolend Road, are occupied by single-family residences. These properties are served by municipal water and private septic systems. The City of Dover uses the Calderwood Well, located to the north, for municipal drinking water. The City periodically monitors water quality in this well.

Surface water bodies in the vicinity of the Landfill include the Cocheco River and the Bellamy Reservoir (Figure 1-1). The Cocheco River is located to the east of the Landfill and is used for recreational purposes (i.e., fishing and boating). The Bellamy Reservoir is located to the south of the Landfill and is used as a drinking water supply for nearby cities and towns.

1.4.2.4 Potential Receptors

Overview

Leachate and impacted ground water flow from the Landfill into the Southern and Eastern Plume areas (Figure 1-2). Potential receptors identified in the area include:

- the perimeter ditch around the Landfill (at least during seasonal high water table conditions);
- the drainage swale that extends from the intersection of Tolend and Glen Hill Roads to the Cocheco River;
- residents living in homes located in and near the flow path of the Eastern Plume and potentially exposed to indoor air affected by VOCs off-gassing from impacted ground water;
- the Cocheco River; and
- the Bellamy Reservoir, a regional surface water supply source.

These receptors are described in the 2004 RFFS (Section 1.3.1.4, pages 1-13 to 1-36) with data summaries that include descriptions of the conditions of surface water, sediment, and air associated with these receptors, as applicable. This section identifies whether new information has been obtained since the 2004 RFFS was prepared and includes references to a summary of the information included in this report, as appropriate.

Perimeter Ditch

The perimeter ditch consists of a shallow drainage ditch (referred to as the "perimeter ditch") located along the southern, western, and eastern toes of the Landfill. A physical description of the perimeter ditch and relevant historical information is included in the 2004 RFFS (Section 1.3.1.4, pages 1-13 to 1-17). Features associated with the perimeter ditch and an indication of the general direction of surface water flow within the ditch are included on Figures 1-4 and 1-5.

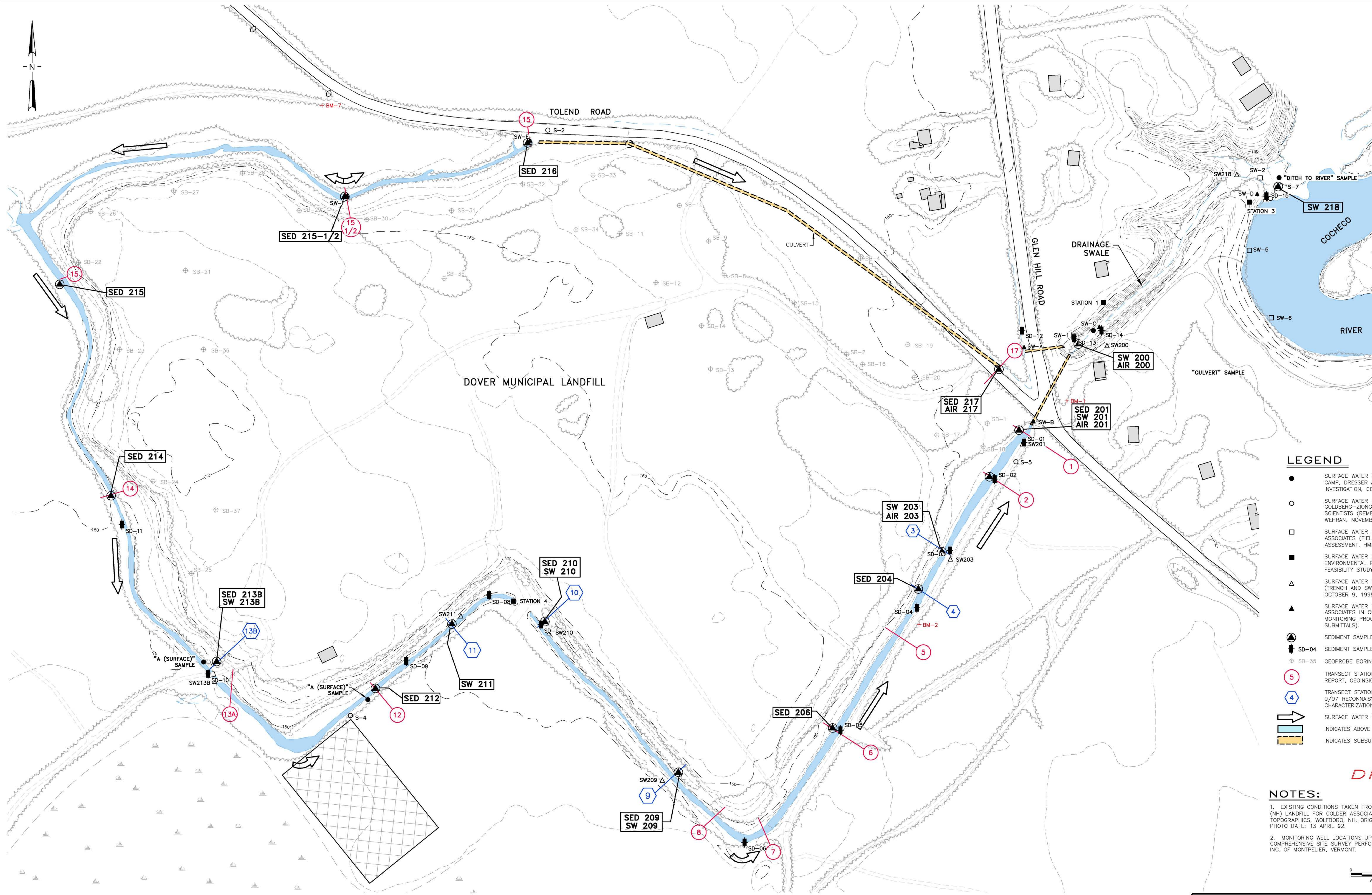
Historical assessments of sediment, surface water, and ambient air associated with the perimeter ditch are summarized in the 2004 RFFS (Section 1.3.1.4, pages 1-13 to 1-17). Since the 2004 RFFS, additional sediment samples were collected and tested for the Air Sparge Trench PDI. The new sediment data are discussed in Section 1.4.11 and the sample locations are included with historical locations on Figure 1-6.

Drainage Swale

The drainage swale is a natural erosional drainage feature that cuts downward through outwash materials associated with the terraced west bank of the Cocheco River. A physical description of the drainage swale and relevant historical information is included in the 2004 RFFS (Section 1.3.1.4, pages 1-17 to 1-19).

Historical assessments of sediment, surface water, and ambient air associated with the drainage swale are summarized in the 2004 RFFS (Section 1.3.1.4, pages 1-17 to 1-19). Since the 2004 RFFS, additional sediment samples were collected and tested from the swale for the air sparge trench PDI. The new sediment data are discussed in Section 1.4.11 and the sample locations are included on Figure 1-6.

Potential impacts to water and sediment quality in the Cocheco River from surface water and sediment discharges associated with the swale were evaluated during the Updated Ecological Risk Assessment completed as part of the 2004 RFFS and during the Focused Ecotoxicity and Human Health Assessment PDI conducted in 2005. The results of these investigations were presented in the Draft Focused Ecotoxicity and Human Health Assessment Activities Cocheco River, Dover Municipal Landfill Superfund Site report, prepared by GeoInsight and dated August 16, 2006.



LEGEND

●	SURFACE WATER SAMPLES COLLECTED IN 1981 AND 1982 BY CAMP, DRESSER AND MCKEE (CDM) (TOLEND ROAD LANDFILL SITE INVESTIGATION, CDM, JULY 1982).
○	SURFACE WATER SAMPLES COLLECTED IN 1985 AND 1986 BY GOLDBERG–ZIONO AND ASSOCIATES AND WEHRAN ENGINEERS AND SCIENTISTS (REMEDIAL INVESTIGATION, GOLDBERG–ZOINO AND WEHRAN, NOVEMBER 1988).
□	SURFACE WATER SAMPLES COLLECTED IN 1989 BY HMM ASSOCIATES (FIELD ELEMENTS STUDY AND SUPPLEMENTAL RISK ASSESSMENT, HMM ASSOCIATES, MAY 18, 1990).
■	SURFACE WATER SAMPLES COLLECTED IN 1990 BY THE U.S. ENVIRONMENTAL PROTECTION AGENCY (DOVER MUNICIPAL LANDFILL FEASIBILITY STUDY, HMM ASSOCIATES, FEBRUARY 28, 1991).
△	SURFACE WATER SAMPLES COLLECTED IN 1997 BY GEOINSIGHT (TRENCH AND SWALE CHARACTERIZATION REPORT, GEOINSIGHT, OCTOBER 9, 1998).
▲	SURFACE WATER SAMPLES COLLECTED IN 2000–2002 BY GOLDER ASSOCIATES IN CONJUNCTION WITH THE ENVIRONMENTAL MONITORING PROGRAM (EMP) (REPORTED IN VARIOUS EMP SUBMITTALS).
	SEDIMENT SAMPLE LOCATION AND SAMPLE ID
SD–04	SEDIMENT SAMPLE LOCATION AND SAMPLE ID, XDD, JULY 2007
SB–35	GEOPROBE BORING – 2001 (APPROXIMATE LOCATION)
5	TRANSECT STATION (TRENCH AND SWALE CHARACTERIZATION REPORT, GEOINSIGHT OCTOBER 9, 1998)
4	TRANSECT STATION WHERE SURFACE WATER WAS PRESENT DURING 9/97 RECONNAISSANCE SURVEY (TRENCH AND SWALE CHARACTERIZATION REPORT, GEOINSIGHT OCTOBER 9, 1998)
	SURFACE WATER FLOW DIRECTION – PERIMETER DITCH
	INDICATES ABOVE GROUND SURFACE WATER FLOW IN DITCH
	INDICATES SUBSURFACE DIVERSION OF PERIMETER DITCH WATER

DRAFT

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.

2. MONITORING WELL LOCATIONS UPDATED IN NOVEMBER 2007, BASED UPON COMPREHENSIVE SITE SURVEY PERFORMED BY VERMONT SURVEY AND ENGINEERING, INC. OF MONTPELIER, VERMONT.

0 100 200
APPROX. SCALE IN FEET

CLIENT: DOVER GROUP			
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE			
TITLE: SEDIMENT SAMPLING AND SURFACE WATER SAMPLING LOCATION PLAN			
DESIGNED: CAB	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW
SCALE: 1" = 100'	DATE: 1/31/08	FILE NO.: 2009d209	PROJECT NO.: 2009-005

GeoInsight
Practical in Nature

FIGURE NO.: 1 — 6

Local Residents – Indoor Air

Single-family residences (generally constructed after 1950) are located along Glen Hill Road to the northeast of the Landfill and along Tolend Road to the east of the Landfill. Most residences include a partial or full basement. Residences located on Glen Hill and Tolend Roads are served by municipal water, but are not served by municipal sewer (i.e., the residents use private, on-site septic systems).

Of the 23 residences located within a 0.25-mile radius of the Site, there are approximately 16 residences within areas where historical ground water impacts attributable to Landfill leachate have been detected. Of these 16 residences, 9 are located on the east side of Tolend Road. Five of the residences are located to the north of the swale, and of these five residences, two are located on the west side of Glen Hill Road and three are located on the east side. The two residences that are located on the west side of Tolend Road are approximately 1,200 feet southeast of the Landfill near the southern edge of the Eastern Plume (Figure 1-2). One of these residences is an older, currently unoccupied house (544 Tolend Road, the northern of the two houses), and the other residence was constructed in 2002 (538 Tolend Road). Depth to ground water along Tolend Road typically ranges from 4 to 7 feet below ground surface (BGS).

A summary of historical assessments was included in the 2004 RFFS (Section 1.3.1.4, pages 1-19 to 1-24). In general, historical data obtained from three sentinel wells (SC-25 to SC-27) installed adjacent to the residential structures located closest to the swale indicated that concentrations of VOCs posing potentially unacceptable indoor air risks were not present in shallow ground water near the residences monitored by the wells. Data from the EMP wells west of Tolend Road also indicated the absence, on a larger scale, of such conditions in the general vicinity of this portion of Tolend Road. The results of historical ground water monitoring events of the sentinel wells located on Tolend Road, the additional EMP monitoring wells located west of Tolend Road, and an evaluation of potential impacts to indoor air are further discussed in the 2004 RFFS (Section 1.3.1.4, pages 1-19 to 1-24).

Tables that summarize the EMP monitoring results for these wells are included in Appendix B.

In September 2006, GeoInsight implemented the Soil Vapor Intrusion (SVI) PDI Work Plan (GeoInsight, 2006) to evaluate the potential for vapor intrusion into residential structures located downgradient of the Landfill along Glen Hill and Tolend Roads, to assess whether existing concentrations of VOCs that are COCs may result in unacceptable indoor inhalation risks, and, if so, to evaluate whether an Early Response Action was warranted. In accordance with the criteria outlined in the SVI PDI Work Plan (Section 5.2.3, page 29), the results of ground water monitoring activities did not indicate an indoor air exposure pathway. The findings of the SVI PDI are further discussed in Section 1.4.6. The evaluation of risk for indoor air was presented in the Draft June 2007 Quarterly Ground Water Monitoring Event and Annual Summary Report, Dover Municipal Landfill Superfund Site, prepared by GeoInsight and dated September 20, 2007.

In addition to monitoring ground water conditions in the vicinity of residential structures, water was also collected from a sump in the basement of the house located at 593 Tolend Road (on the east side of Tolend Road approximately 200 feet east of the east corner of the Landfill – see Figure 1-2). Samples were collected in May 2000 and May 2001, and results indicated that VOCs were not detected in the samples at concentrations above practical quantitation limits (PQLs). In addition, a soil sample obtained from the bottom of the sump during October 2000 and several shallow soil samples from the garden located to the south of the house were analyzed for VOCs using USEPA Method 8260B. VOCs were not detected in the soil samples from the sump or the garden at concentrations above PQLs (5 micrograms per kilogram [μg/kg]).

Since the 2004 RFFS was prepared, a water sample was collected from a sump in the basement of the 538 Tolend Road residence during the June 2006 EMP sampling event and analyzed for VOCs by USEPA Method 8260B. Toluene was detected at a concentration of

4 micrograms per liter (µg/L; below the NHDES GW-2 standard of 50,000 µg/L). Other VOCs were not detected in the sump water sample. PQLs for VOCs ranged from 1 to 5 µg/L.

Cocheco River

The Cocheco River is located approximately 600 feet east of the Landfill. A physical description of the river and relevant historical information is included in the 2004 RFFS (Section 1.3.1.4, pages 1-24 to 1-27).

Available information suggests that the Cocheco River is a location of ground water discharge in the vicinity of the Landfill and that the Eastern Plume is not migrating beneath the river (2004 RFFS, Section 1.3.1.4, pages 1-24 to 1-27). This information is consistent with general hydraulic conditions associated with ground water-surface water relationships in most of the glaciated regions of New England and general hydraulic conditions associated with regional surface water bodies and rivers.

A summary of surface water and sediment analyses was included in the 2004 RFFS (Section 1.3.1.4, pages 1-24 to 1-27). Analysis of surface water samples collected in November 2002 (as part of the RFFS) for iron and arsenic indicated that only iron exceeded Surface Water Quality Standards (SWQSs; see Section 2.5.2.2, pages 2-20 to 2-25 of 2004 RFFS). Analysis of samples collected in November 2002 (as part of the RFFS) indicated that concentrations of arsenic were above the applicable USEPA sediment ecotoxicity screening threshold criterion for benthic organisms in 4 of the 15 downstream sediment samples (see Section 2.5.2.2, pages 2-20 to 2-25 of 2004 RFFS). Concentrations above the screening level do not necessarily indicate that adverse effects are likely, only that there is a potential for such effects. It was concluded that additional analysis was required to evaluate potential adverse effects on benthic organisms in the approximately 600 feet of habitat along the near side of the river where this screening level was exceeded.

In response to the findings in the 2004 RFFS, a Focused Ecotoxicity and Human Health Assessment PDI was initiated in November 2005 to further evaluate potential ecological and human health risks associated with the presence of arsenic in sediment along the west bank of the Cocheco River. Arsenic was not detected in sediment samples collected during the PDI Work Plan activities at concentrations at or above the laboratory PQL. Elevated concentrations of arsenic (above the USEPA ecotoxicity threshold) similar to those detected during the RFFS sediment sampling program were not observed in the sediment samples collected during the PDI Work Plan activities. The objectives of the PDI are presented in Section 1.4.6, and a more detailed discussion of the results of the Focused Ecotoxicity and Human Health Assessment was presented in the Draft Focused Ecotoxicity and Human Health Assessment Activities Cocheco River, Dover Municipal Landfill Superfund Site report, prepared by GeoInsight and dated August 16, 2006. The results of historical ground water monitoring events of nearby monitoring wells located east and west of the Cocheco River are presented in the 2004 RFFS Section 1.3.1.4, pages 1-24 to 1-27.

Bellamy Reservoir

The Bellamy Reservoir is located in an area of relatively little topographic relief known as the Mallego Plains. The north and east borders of the Reservoir are located between 1,500 to 2,000 feet to the south and southwest of the Landfill. The reservoir is classified by the State of New Hampshire as a Class A surface water body (i.e., drinking water resource). A physical description and summary of historical information was presented in the 2004 RFFS (Section 1.3.1.4, pages 1-27 to 1-30).

Results of the Southern Plume PDI (GeoInsight, 2007) indicate that impacted ground water extends approximately 600 feet south of the Landfill. The objectives and a discussion of the findings of the Southern Plume PDI were presented in Section 1.4.6 and 1.4.9, respectively.

Since the 2004 RFFS, surface water sample stations were established along the northern shore of the Bellamy Reservoir as part of the Southern Plume PDI. Surface water samples were collected from these stations as part of the EMP program. Results are discussed in Section 1.4.10.

1.4.3 Summary of Institutional Controls

Since the detection of impacts to ground water in the vicinity of the Landfill in the late 1970s, a number of measures have been taken to limit potential exposure to conditions associated with the Landfill. This section provides a brief summary of the risk management measures that have been implemented at the Site.

Based upon the results of early assessment activities at the Landfill, the City of Dover extended the municipal water supply line to residences located along Tolend and Glen Hill Roads in 1981 and 1982 (residences in these areas were previously served by private wells). Evaluations completed in 1988 during the RI confirmed that homes located to the east and south of the Landfill along Tolend Road and Glen Hill Road were connected to the municipal water system (GZA and Wehran, 1988). Residences constructed on Tolend and Glen Hill Roads in the vicinity of the Landfill since the 1991 ROD was issued are also connected to the municipal water supply line. The location of the municipal water supply line is shown on Figure 2 in Appendix A.

At approximately the same time that the municipal water line was installed, a metal chain-link fence and gates were constructed along Tolend Road to the north and south of the Landfill entrance. A chain-link fence and metal gate were also installed at an ancillary access road to the northwest corner of the Landfill. The northwest corner of the Landfill is accessed via a dirt road located in the forested wetlands to the north of the Landfill. The location of the fence is shown in Appendix A. The Landfill area was also posted with "No Trespassing," "No Hunting," and "Hazardous Materials Present" signs.

In May 1987, the City of Dover instituted Ordinance Number 9-87 establishing a Hazardous Waste Landfill District. The ordinance was designed to alert the public and prohibit development activities in areas potentially affected by the Landfill until final cleanup and proper closure is completed. A copy of the ordinance is included in Appendix A.

In May 1991, the City of Dover instituted Ordinance Number 13-91 prohibiting the installation or use of a private well within 1,500 feet of the Landfill except for purposes related to the cleanup, testing, and remediation associated with the Landfill. A copy of the ordinance is included in Appendix A.

The Town of Madbury corporate boundary is located within several hundred feet of the west border of the Landfill (Figure 1-1). In August 1992, the Town of Madbury adopted a protective zoning district referred to as the Tolend Landfill Overlay District. Installation of wells, other than those directly related to the cleanup, testing, and remediation of the Landfill, is prohibited within the district. The overlay district includes all properties located within the Town of Madbury that are located between the Landfill and the Bellamy Reservoir and, to the west, the associated Mallego Brook (which was dammed to create the Bellamy Reservoir). A copy of the Overlay District is included in Appendix A.

Additional development or installation of wells for purposes other than those authorized by the ordinance and overlay district have not occurred within the vicinity of the Landfill since the ordinances and overlay district were established. In addition, the areas included in the overlay district or within jurisdiction of the ordinances consist predominantly of forested wetlands. Wetlands mapping and assessment were performed during the PDI (Golder, 1995). Figures 2-7, 2-8, and 8-1 from the PDI Report (Golder, 1995) are included in Appendix A. Because of limitations on development activities in wetlands and related septic system requirements, much of the land potentially affected by ground water impacts associated with the Landfill is not suitable for future development. The City of Dover currently does not plan to install municipal sewer services within the general area of the Landfill, and there are no current policy initiatives, either federal, state, or local, to significantly change existing restrictions to filling wetland areas for development purposes.

In 2001, the City of Dover purchased the last privately owned parcel of land located adjacent to the Landfill. Therefore, the City currently owns the land located adjacent to the east, northwest, west, and south of the Landfill (the land to the north and northeast of the Landfill is occupied by Tolend Road). With the exception of several small lots located along Tolend Road to the east and southeast of the Landfill, the City owns all of the parcels within the area of ground water impacts and, therefore, controls future use of these properties. Properties in the vicinity of the Landfill that are owned by the City are illustrated on the plan in Appendix A.

In 2007, the Group submitted an application for a Groundwater Management Permit (GMP) to define the boundary of a Groundwater Management Zone (GMZ). The application included a figure illustrating the proposed GMZ and a monitoring schedule utilizing existing monitoring wells. The GMZ was established based upon a review of geologic characteristics of the Site, estimated ground water flow patterns, and distribution of COCs in ground water at concentrations above Interim Cleanup Levels (ICLs) as presented in the 2004 RFFS and as characterized during recent PDI activities. The recommended boundaries of the GMZ coincide with the boundaries of several properties owned by the City of Dover.

1.4.4 Environmental Monitoring Program

Ground water quality conditions at the Site were characterized during the RI/FS, FES, and PDI activities and have been monitored during EMP events completed on a semi-annual basis since 1993. Including the results of additional monitoring of Landfill and Landfill toe wells that was initiated by the Group in 1995 (concurrently with EMP events), EMP events have obtained ground water quality data from 8 wells located within the Landfill, 19 wells located along the toe of the Landfill, 21 wells located to the east of the Landfill (i.e., east of the ground water hydraulic divide within the area occupied by the "Eastern Plume"), and 9 wells located to the south and west of the Landfill (i.e., west of the ground water hydraulic divide within the area occupied by the "Southern Plume"). Table 1-1 includes a list of wells monitored under the EMP.

TABLE 1-1
SUMMARY OF EMP AND HISTORICAL DATABASE WELLS
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

1981-2006 HISTORICAL DATABASE WELLS*						
1995-2007 EMP DATABASE WELLS				**NON-EMP WELLS**		
EMP WELLS	**SENTINEL WELLS**	**NEW COUPLETS**	**ADDITIONAL WELLS**	**WELLS INSTALLED 1981-2001**		**SVI PDI**
SC-1US	SC-25	SC-22S	SC-7UUI	SC-6US	SC-2UUI	SC-28
SC-7US	SC-26	SC-22I	SC-7LUI	MW-102S	SC-3U	SC-29
SC-8US	SC-27	SC-22D	SC-8UUI	MW-102U	SC-3UUI	SC-30
SC-10US		SC-23S	SC-8LUI	MW-105U	SC-4U	SC-31
OW-4A		SC-23D	SC-9US	MW-106S	SC-20US	SC-32
EP-1S		SC-24S	SC-10UUI	MW-106U	SB-A1	SC-33
EP-1I		SC-24I	SC-10LUI	SB-A1	SB-A2	SC-34
EP-1D		SC-24D	SC-11US	SB-A2	B-13WT	SC-35
EP-2S			SC-11UUI	SB-B3	B-13U	SC-36
EP-2D			SC-12US	SB-C1	MW-102S	
SB-4D			SC-12UUI	SB-C2	MW-105S	
SB-5D			SC-13US	SB-8U		
SB-8D			SC-14US	SB-10WT		
SB-B1			SC-15US	SB-10D		
SB-B2			SC-15UUI	B-1U		
SB-D1			SC-16US	B-3U		
SB-D2			SC-16UUI	B-4WT		
SB-GW-3L			SC-18US	B-4U		
SB-GW-3U			SC-18UUI	B-5WT		
SB-GW-3I**			MW-101U	B-5U		
SB-10I**				B-6U		
MW-103S				B-7U		
MW-103U				B-8U		
MW-104S				B-9U		
MW-104U				B-10U		
B-2U				B-11U		
B-8WT				B-12U		
B-9WT				B-13WT		
B-9U				B-13U		
				OW-1A		
				OW-2A		
				OW-3		
				OW-5		
29 WELLS	**3 WELLS**	**8 WELLS**	**20 WELLS**	**44 WELLS**		**9 WELLS**

Notes:
1. EMP - Environmental monitoring program.
2. * Historical database includes EMP and wells installed during the period between 1981 and 2006.
3. SVI PDI = wells installed for the Soil Vapor Instrusion Pre-Design Investigation.

During the period of the bioremediation pilot project (1996 to 2001), the scope of the EMP was modified to include new monitoring wells. These additional wells were monitored during subsequent EMP events. To further evaluate hydraulic and ground water quality conditions to the east and southeast of the Landfill, eight additional monitoring wells were installed in June 2001. The eight wells were installed as three separate groups of wells (one well couplet and two nests of three wells) located to the east-southeast of the Landfill on the south side of Tolend Road. Well nest SC-22S/I/D was installed adjacent to Tolend Road approximately 550 feet east of the Landfill entrance. Well couplet SC-23S/D and nest SC-24S/I/D were installed in the forested wetland area to the southeast of the Landfill. These wells have been monitored with the EMP since August 2000.

To further evaluate background geochemical conditions in the Landfill vicinity, two additional intermediate depth monitoring wells were installed to the southwest of the Landfill in June 2001. These two wells (SB-10I and SB-GW-3I) were installed at locations where existing shallow and deep wells were already present. These wells have been monitored with the EMP since June 2001.

Shallow ground water monitoring wells were installed on three properties located between the southeast portion of the Landfill and the Cocheco River. The wells, referred to as "sentinel wells," were installed to monitor shallow ground water conditions in the vicinity of residences on these properties (designated SC-25, SC-26, and SC-27). This monitoring focused on conditions that could potentially impact indoor air quality in the residential structures (i.e., VOCs). The results of monitoring indicated that, along Tolend and Glen Hill Roads, shallow ground water (within the depth of basements) did not contain elevated concentrations of dissolved phase VOCs.

1.4.5 Summary of Remedial Actions and Evaluations

This section includes a brief overview of the perimeter ditch and drainage swale characterization and remedial actions performed in December 1998 and a monitored natural attenuation (MNA) evaluation. These discussions were presented in more detail in the 2004 RFFS (Section 1.3.3.1, pages 1-38 to 1-40, and Section 1.3.3.4, pages 1-44 to 1-50, respectively).

1.4.5.1 Perimeter Ditch and Drainage Swale Characterization and Remedial Actions

Assessment activities were completed in 1997 to evaluate conditions in the perimeter ditch and drainage swale. The results of sediment, surface water, and air analyses performed in December 1997; an evaluation of the potential risks associated with the environmental conditions of the perimeter ditch and drainage swale; and proposed interim remedial actions to manage potential risks (during the period of the bioremediation pilot project) were included in the October 1998 Trench and Swale Characterization Report (GeoInsight, 1998). Analytical data summary tables from the 1998 Trench and Swale Characterization Report were included in Appendix D-1 of the 2004 RFFS.

The proposed interim remedial action for the drainage swale sediment was consistent with the draft Final (100 percent) Design Report for the 1991 ROD Remedy (Golder, 1996). The interim remedial actions for the ditch consisted of focused sediment hotspot removal and sediment containment through the installation of weirs, traps, and other migration barriers upstream of the discharge to the drainage swale.

The interim remedial activities were described in the 2001 report titled "Interim Remedial Action Summary Report" (GeoInsight, 2001). Analytical data summary tables from the 2001 Interim Remedial Action Summary Report were included as Appendix D-2 of the 2004 RFFS. The response letter from the NHDES dated November 6, 2002 regarding the Interim Remedial Action Summary Report was included in Appendix D-3 of the 2004 RFFS.

1.4.5.2 Monitored Natural Attenuation

A detailed evaluation of natural attenuation at the Landfill was included in the 2004 RFFS (Section 1.3.3.4, pages 1-44 to 1-50). The 2004 RFFS summary reported that available data indicated that MNA may be an effective remedy for VOCs at the Site. Some of the identified Site-specific factors that facilitate MNA were anaerobic conditions within the plume and aerobic conditions at the plume margins. In addition, downgradient wetlands are another rich source of organic carbon conducive to biodegradation (Lorah et al., 1997). Data supporting the USEPA's three lines of evidence included:

- ten years of VOC data (EMP) showing decreasing contaminant concentrations over time;
- the presences of daughter products (including dissolved gases) indicative of complete *in situ* degradation to innocuous end products; and
- laboratory and field data indicating the presence of bacteria capable of degrading the chlorinated compounds of concern.

However, USEPA and NHDES concluded that MNA was not a viable site-wide remedy for all contaminants. USEPA issued an Addendum to the 2004 RFFS documenting its perspective.

1.4.6 Summary of Pre-Design Investigation Activities and Objectives - 2005 to 2007

The study areas for PDI activities are illustrated on Figure 1-3.

1.4.6.1 Northwest Landfill Pre-Design Investigation

Historically, ground water impacts associated with the Landfill were primarily observed to the south and southeast of the Landfill (in the general direction of regional ground water flow). Ground water impacts were not typically detected to the north and northeast of the Landfill in areas identified to be hydraulically upgradient and cross gradient of the Landfill (hydraulic conditions are described in Section 1.4.8).

A summary of historical surface water data presented in the 2004 RFFS (Section 1.3.3.3, pages 1-42 to 1-44) indicated that chlorinated VOCs detected in surface water samples collected at Stations SW-A and SW-E appeared to be associated with a localized condition near the Landfill perimeter ditch in the vicinity of Station SW-E. Because of the similarity in the types and ratios of VOC concentrations in samples collected from the two Stations, it appeared that the surface water impacts detected at Station SW-A were associated with the impacts observed at Station SW-E.

A preliminary evaluation of ground water quality was performed in 2001 as described in the 2004 RFFS (Section 1.3.3.3, pages 1-42 to 1-44) that included 37 soil borings within the north and northwest portion of the Landfill. Results indicated that the highest VOC concentrations were identified in ground water in the vicinity of the northern perimeter ditch (see results for SB-30 and SB-36). However, the location of a specific hotspot could not be identified in 2001 based upon the preliminary data set. Conditions at surface water sampling Station SW-E and along the north portion of the Landfill were further evaluated during Northwest Landfill PDI.

The objectives of the Northwest Landfill PDI (GeoInsight, 2005) were to evaluate the location(s), magnitude, and extent of the source(s) of VOCs detected in surface water in the northern portion of the perimeter drainage ditch. To complete the assessment, activities performed between December 2005 and January 2006 included:

- a physical survey of the north perimeter ditch;
- the collection of discrete surface water and ground water samples for field and laboratory analyses for VOCs; and
- advancing soil borings within the Study Area to evaluate subsurface stratigraphy within the northwest and north central portion of the Landfill.

Information related to the distribution of COCs within the interior of the Landfill is discussed in Section 1.4.9 and results of surface water analyses are discussed in Section 1.4.10.

1.4.6.2 Southern Plume Pre-Design Investigation

The objectives of Phase I of the Southern Plume PDI (GeoInsight, 2006) were to evaluate the magnitude and extent of impacts of COCs in ground water located to the south of the Landfill and, in particular, the area between the Landfill and the Bellamy Reservoir. To evaluate these objectives, activities performed from July 2006 to June 2007 included:

- collection and analyses for VOCs of discrete ground water samples from the upper sand (US), upper upper interbedded (UUI), and lower upper interbedded (LUI) stratigraphic units at 22 locations within the Southern Plume Study Area;
- advancement of five soil borings within the Southern Plume Study Area to further characterize Site stratigraphy and the depth to the upper surface of the Marine Clay unit;
- laboratory analyses of soil for grain size and total organic carbon (TOC); and
- surface water gauging.

The distribution of COCs south of the Landfill is discussed in Section 1.4.9 as it relates to conditions in the southwest corner of the Landfill, a focus area for the SC discussion.

1.4.6.3 Soil Vapor Intrusion Pre-Design Investigation

The objectives of the PDI SVI Work Plan (GeoInsight, 2006) were to evaluate the potential for vapor intrusion into residential structures located downgradient of the Landfill along Glen Hill and Tolend Roads. In addition, if an exposure pathway was confirmed, to assess whether the COC concentrations may result in unacceptable indoor inhalation risks and, if so, whether an Early Response Action is warranted. To achieve these objectives, activities performed from August 2006 to June 2007 included:

- installing nine shallow monitoring wells (SC-28 to SC-36) at locations upgradient of residences located along Tolend Road;
- collecting ground water samples from the newly installed wells and existing wells (SC-4US, SC-5US, SC-25, SC-26, and SC-27) and analyzing them for VOCs by USEPA

Method 8260B;

- comparing the analytical results of the analyses to USEPA Generic Screening Levels for Target Ground Water Concentrations and reviewing these results in accordance with the schedule outlined in Section 5.2.3 of the PDI Work Plan (page 29); and
- collecting supplementary ground water samples for VOC analyses from the new and existing wells on a quarterly schedule (September and December 2006 and March and June 2007) for one year.

An indoor air exposure pathway was not identified in the Eastern Plume during the PDI and supplementary monitoring. Because this investigation is associated with the Eastern Plume and not SC, additional discussion of this issue is not presented in this SC-FFS.

1.4.6.4 Air Sparging Trench Pre-Design Investigation

The 2004 RFFS presented several remedial options, including the construction of an air sparging trench as an on-site SC measure for COC-impacted ground water migrating from beneath the Landfill. The segmented treatment trench is to be designed such that COC concentrations in ground water flowing out of the treatment trench will meet ICLs. The activities performed to complete the Phase I objectives for the Air Sparging Trench PDI (XDD, 2007) included:

- direct push investigations to assess ground water impacts, evaluate the variability of ground water quality within the Landfill, and provide soil information for the trench design;
- installing a ground water monitoring well cluster near the northeast corner of the Landfill (designated MW-107) to provide additional hydraulic data in this area of the Site; and
- collecting sediment samples in the perimeter ditch and drainage swale for arsenic analyses.

The distribution of COCs within the Landfill footprint is discussed in Section 1.4.9, and the results of sediment sampling in the perimeter ditch and drainage swale are presented in Section 1.4.11.

1.4.6.5 Focused Ecotoxicity and Human Health Assessment Pre-Design Investigation

The objectives of the Focused Ecotoxicity and Human Health Assessment PDI (GeoInsight, 2005) were to evaluate potential ecological and human health risks associated with the presence of arsenic above initial USEPA Ecotoxicity Threshold values in sediment located along the west bank of the Cocheco River in the vicinity of the Landfill. The assessment was undertaken in response to a finding in the RFFS that arsenic was present in the uppermost layer of sediment along the west bank of the Cocheco River at concentrations that could adversely affect benthic communities.

To evaluate potential ecological and human health risks associated with the presence of arsenic in sediment, activities performed between November 2005 and January 2006 included:

- collecting surface water and sediment samples and analyzing them for general chemistry parameters and physical characteristics within the Study Area;
- collecting composite sediment samples from representative sections of the Cocheco River within the Study Area, including one upstream (background) location;
- sediment toxicity bioassays for acute effects using 10-day *Hyalella azteca* and 10-day *Chironomus dilutus* (formerly known as *C. tentans*) tests; and
- updating the human health risk calculations completed by the USEPA for potential exposures to arsenic in sediment.

The results of these investigations were presented in the Draft Focused Ecotoxicity and Human Health Assessment Activities Cocheco River, Dover Municipal Landfill Superfund Site, prepared by GeoInsight and dated August 16, 2006. Testing results did not identify adverse impacts on growth or survivability of the test organisms. Because this investigation is associated with the Eastern Plume and not SC, further discussion is not presented in this SC-FFS.

1.4.7 Summary of New Information

Newly obtained information from the recently completed PDI activities that influenced the proposed change to the SC-Ex remedy included:

- identification of the Southern Plume center of mass at a location relatively close to the southwest corner of the Landfill;
- confirmation of the presence of a hotspot of relatively high COC concentrations in ground water in the northwest portion of the Landfill that serves as a source of surface water VOC impacts in the northern portion of the perimeter ditch that ultimately discharges to the drainage swale and the Cocheco River;
- the absence of other COC hotspots within the Landfill; and
- the presence of relatively dilute COC concentrations along and upgradient of most of the Landfill toe.

New information identified by the completion of PDI assessment activities relative to the SC remedy is further discussed in the sections that follow. In general, however, the Southern Plume PDI results obtained to date indicate that the Southern Plume center of mass is located relatively close to the southwest corner of the Landfill. Because of the plume center of mass location, ground water extraction operations are likely to be sited relatively close to the western end of the air sparging trench with the resulting potential for hydraulic interference with the SC remedy function. Accordingly, operation of an extraction system to address the Southern Plume will add uncertainty with regard to potential hydraulic interferences with the function of the sparging trench and the local THF recirculation system.

In addition, the results of the Northwest Landfill and Trench PDIs obtained to date indicated that the Northwest Landfill hotspot may be the source of the THF impacts observed at the southwest corner of the Landfill. Accordingly, recirculation of ground water back into the Landfill footprint upgradient of the southwest toe may disperse the THF impact, complicating its treatment. In any event, recirculation will likely interfere with or reduce the efficiency of flushing to and capture by the trench of COCs present in the Northwest Landfill hotspot area.

The results of the Trench PDI also indicated that the COC concentrations expected to enter the trench along much of the Landfill toe were relatively dilute, leading to re-consideration of the cost-benefit analysis for SC.

1.4.8 Hydrogeology

This section presents descriptions regarding the Site stratigraphy, ground water flow patterns and properties, and surface water flow features.

1.4.8.1 Stratigraphic Overview

The overburden materials in the Landfill area consist of upper and lower hydrostratigraphic units that are separated by a layer of Marine Clay that has an average thickness of approximately 30 feet. The depth to the Marine Clay varies across the Site. The clay layer is present at the ground surface to the northwest of the Landfill and generally slopes downward to the south and east. The clay layer is typically located 50 to 70 feet below grade at the southern and eastern toe of the Landfill. The clay layer is deeper on the eastern side of the Landfill. The clay layer forms a barrier to the vertical flow of ground water between the upper and lower hydrostratigraphic units. Cross-sections of the Dover region and the Site developed by BCI Geonetics (BCI's; 1990 report to the City of Dover) and GZA (GZA and Wehran, 1988), respectively, were included in Appendix C of the 2004 RFFS. Structural contour maps of the US, UUI, LUI, and Marine Clay units developed for the 1995 PDI (Golder, 1995) were also included in Appendix C of the 2004 RFFS.

The upper hydrostratigraphic unit is divided into three sub-units including (from the ground surface downward) a US unit, a UUI unit, and a LUI unit. The US unit consists of fine to medium sand with relatively little silt and clay. The observed thickness of the US unit varies, ranging from being relatively thin or absent in the northwestern portion of the Landfill to a maximum observed thickness of 37 feet in the vicinity of well series SC-8 (located along the south central toe of the Landfill). The typical thickness of the US unit is approximately 15 to

20 feet across the Landfill. The thickness of the US unit along the downgradient perimeter (i.e., south and east toe) of the Landfill ranges from 0 to 37 feet and averages approximately 18 feet.

The UUI and LUI units consist of fine to very fine sand with interbedded layers of silt and clay. Analyses completed during the PDI indicated that grain size decreases with depth and the silt and clay content increases with depth. The contact between the UUI and the LUI is gradational and is not always clearly identifiable. The UUI and LUI units are thin or absent in the northwest portion of the Landfill where the Marine Clay layer is present at the ground surface. The thickness of the combined UUI/LUI units along the downgradient perimeter (i.e., south and east toe) of the Landfill ranges from 10 to 50 feet and averages approximately 30 feet.

1.4.8.2 New Stratigraphic Information

During the Northwest Landfill investigation, the uppermost layer of native soil encountered in the Study Area was comprised of fine to coarse sand historically described as the US unit. Within the northwest Landfill Study Area, the US unit ranged from 4 to 12 feet in thickness. The US unit was typically underlain by interbedded fine sand and clay that ranged from 6.5 to 15 feet in thickness. The interbedded soil descriptions were consistent with historical descriptions of the UUI. The interbedded materials generally consisted of thicker layers of fine sand with thin clay lenses near the top of the unit, grading with depth to thicker layers of clay and thinner fine sand layers toward the base of the unit. The UUI unit was underlain by grayish-green Marine Clay (i.e., the Marine Clay Unit). Within the Landfill footprint, the native soil layers were overlain by a soil cover and solid waste deposits that were typically 2 and 10 feet thick, respectively.

During the Southern Plume PDI, five soil borings were advanced with a geoprobe in the area between the Landfill and the Bellamy Reservoir. The boundary between the US and UUI units was typically identified as the first observation of a sequence of interbedded layers of fine sand and silt. The interbedding was typically first observed at depths between 10 and 15 feet BGS. The US unit consisted predominantly of sand with occasional thin layers of coarse mica flakes. Organic materials and oxidation staining (i.e., brown to orange color) were observed in shallow portions of the US unit, typically within the top 10 feet.

The UUI unit was characterized by the presence of interbedded layers of coarser and finer soil. Interbedded sequences typically included layers that were less than 4 inches in thickness and that alternated between fine sand and silty clay layers. In addition to interbedded sequences of layers between 0 and 4 inches in thickness, some fine sand layers contained a high frequency of densely spaced layers of fine-grained media. The UUI unit also contained thicker (i.e., 1 to 3 feet) continuous layers of fine sand or silty clay. Based upon observations during ground water sampling, discussed below, thicker layers of clay were inferred in the UUI unit at depth intervals ranging from 25 to 50 feet BGS in the western portions of the Southern Plume Study Area.

The elevation of the transition from the UUI unit to the LUI unit was estimated based upon the observation of increased clay content in the interbeds of fine-grained material. In general, coarse-grained layers (i.e., sand layers) were thinner than fine-grained layers in deeper portions of the UUI unit.

The top of the Marine Clay unit was estimated based upon observations during ground water sampling during the Southern Plume Phase I PDI. After the geoprobe sampler encountered the Marine Clay unit, samples were difficult to retrieve because of the high plasticity of the clay unit. The sampling apparatus typically "sank" into the clay unit under the weight of the drilling tools, and soil samples could not be retrieved from vibrating the sampler into the clay unit. The depth at which the geoprobe sampling equipment began to behave in this manner was estimated to be in the vicinity of the top of the Marine Clay unit.

Information related to the depth of the Marine Clay was updated based upon observations made during the Northwest Landfill, the Southern Plume, and the Air Sparge Trench PDIs.

An updated contour map of the Top of the Marine Clay is included herein as Figure 1-7. Copies of the 1995 Golder Elevation of Marine Clay (Figure 5-5) and Top of Marine Clay Map (Figure 7) in the Southern Plume Summary Report are included in Appendix C for reference.

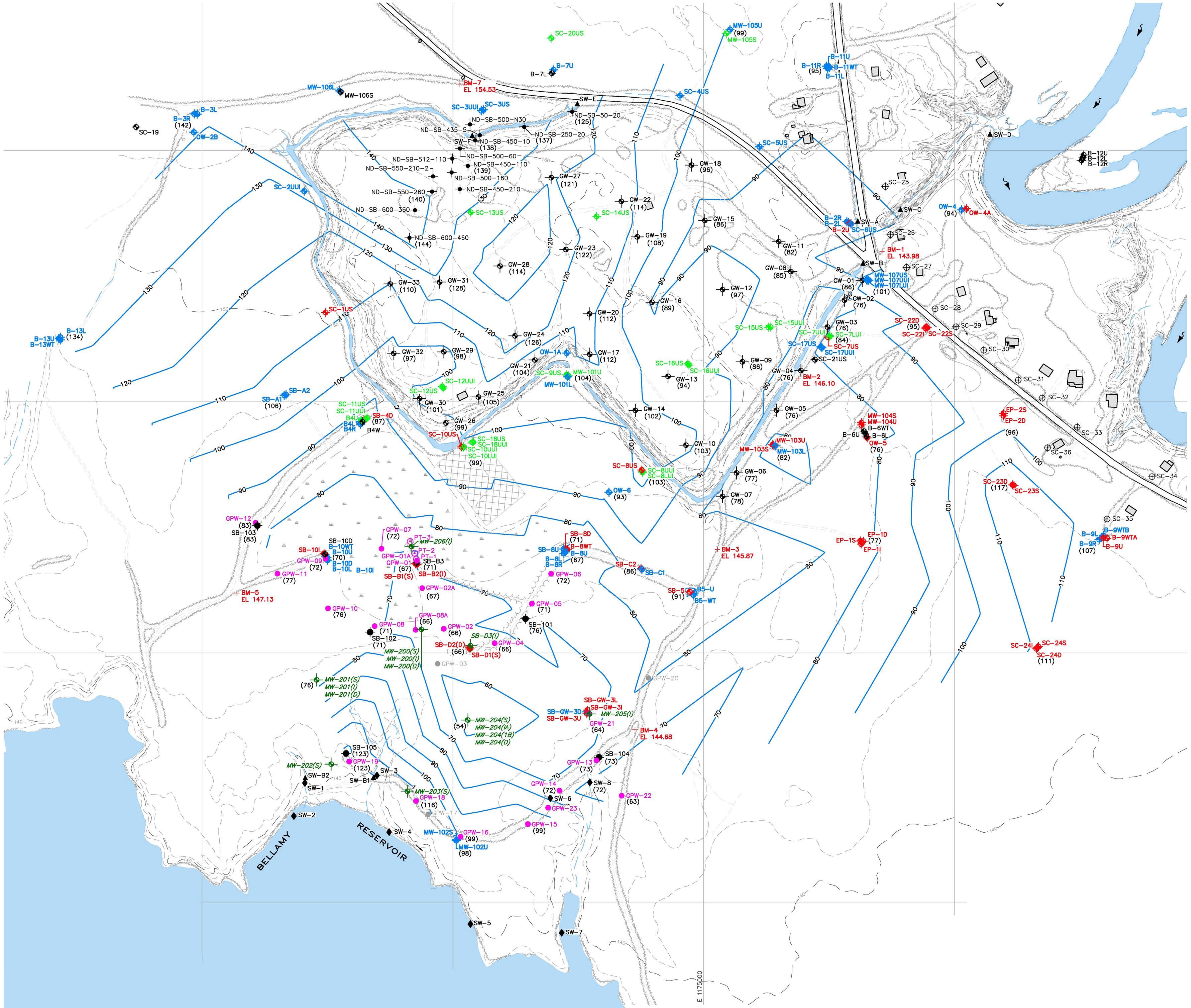
The elevation of the top of the Marine Clay unit estimated by Golder in 1995 (Figure 5-5 of 1995 PDI Report) indicated that the Marine Clay unit was deepest within the area approximately 400 feet south of the Landfill in the area of the SB-B and SB-D well clusters. It also indicated that the clay sloped downward to the south and east, dipping under the Bellamy Reservoir.

Based upon the new information, the top of the Marine Clay surface (see Figure 1-7) appeared to slope from northwest to southeast in the area under the western lobe of the Landfill. It also indicated that the top of clay elevation was relatively shallow (approximately 20 feet BGS) adjacent to the north shore of the Bellamy Reservoir.

With regard to the depth of the Marine Clay at the toe of the Landfill where the SC-A trench remedy is proposed, the Marine Clay elevation appears to range from 50 to 70 feet BGS. The Marine Clay is deeper on the eastern side of the Landfill (70 feet BGS) relative to the area south of the western lobe (i.e., southwest corner). For this area of the Site, observations of the depth of the Marine Clay during recent PDI activities were generally consistent with the historical estimates.

1.4.8.3 Ground Water Flow Patterns

From October 1993 to the present, ground water elevation data have been collected from Site monitoring wells (approximately 130 wells) on a quarterly basis. Historical ground water elevation measurements for the US, UUI, and LUI unit monitoring wells are summarized in tables included in Appendix B. The depths to ground water in monitoring wells screened within the US unit are generally less than 10 feet below grade with the exception of wells



LEGEND

SC-7US	EMP WELL SAMPLING LOCATION AND DESIGNATION
SC-7UUI	ADDITIONAL WELL SAMPLING LOCATION AND DESIGNATION (DECEMBER 1995 TO PRESENT)
MW-17US	WELL LOCATIONS WHERE EMP WATER LEVELS ARE OBTAINED (IE, EMP SAMPLING IS NOT PERFORMED)
OW-2	WELL LOCATIONS WHERE WATER LEVELS ARE NOT OBTAINED AND SAMPLING IS NOT PERFORMED
SW-A	EMP SURFACE WATER SAMPLING LOCATION
ND-SB-250-20	SOIL BORING LOCATION AND DESIGNATION
SC-30	SENTINEL WELL SAMPLING LOCATION AND DESIGNATION
150	EXISTING TOPOGRAPHIC CONTOUR
140	APPROXIMATE TOP OF MARINE CLAY (ELEVATION MSL)
(117)	APPROXIMATE ELEVATION OF TOP OF MARINE CLAY
	PAVED ROAD
	UNPAVED ROAD OR DRIVE

SOUTHERN PLUME PDI LOCATIONS:

GPW-21	GEOPROBE BORING LOCATION – WATER SAMPLES OBTAINED BY DISCRETE METHODS (GEOINSIGHT, 2006)
GPW-20	PROPOSED PDI GEOPROBE BORING LOCATION – NOT PERFORMED
SB	SOIL BORING LOCATION (GEOINSIGHT, 2006)
SW-3	SURFACE WATER GAUGING STATION
MW-201	SOIL BORING/MONITORING WELL (GEOINSIGHT, 2007)

AIR SPARGE TRENCH PDI LOCATIONS:

GW-04	GEOPROBE BORING LOCATION – WATER SAMPLES OBTAINED BY DISCRETE METHODS (XDD, 2007)

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.

2. MONITORING WELL LOCATIONS UPDATED IN NOVEMBER 2007, BASED UPON COMPREHENSIVE SITE SURVEY PERFORMED BY VERMONT SURVEY AND ENGINEERING, INC. OF MONTPELIER, VERMONT.

3 TOP OF MARINE CLAY ELEVATION DATA CONTOURED USING LINEAR TRIANGULATION INTERPOLATION METHODS USING AUTODESK LAND DESKTOP SOFTWARE. SMOOTHING TECHNIQUES WERE NOT APPLIED TO THE DATA SET.

4. FIGURE UPDATED AND REVISED USING FIGURE 7 OF THE SOUTHERN PLUME PDI SUMMARY REPORT. NOTE THAT DATA POINTS GW-01 TO GW-33, MW-201 AND MW-204 WERE ADDED, AND DATA POINTS FOR SC-12UUI, SC-15UUI, AND SC-16UUI WERE REMOVED.

5. TOP OF MARINE CLAY WAS ESTIMATED BY INDIRECT OBSERVATIONS DURING WATER SAMPLING BY DISCRETE METHODS. (I.E. "GPW" AND "GW" LOCATIONS).

6. TOP OF MARINE CLAY WAS OBSERVED DURING ACTUAL SOIL BORING ACTIVITIES FOR LOCATIONS OTHER THAN THE "GPW" AND "GW" LOCATIONS.

DRAFT

0 200 400
APPROX. SCALE IN FEET

CLIENT: DOVER GROUP			
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE			
TITLE: UPDATED ELEVATION OF TOP OF MARINE CLAY			
DESIGNED: KEZ	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW
SCALE: 1" = 200'	DATE: 1/30/08	FILE NO.: 2009D217	PROJECT NO.: 2009-009
FIGURE NO.: 1-7			

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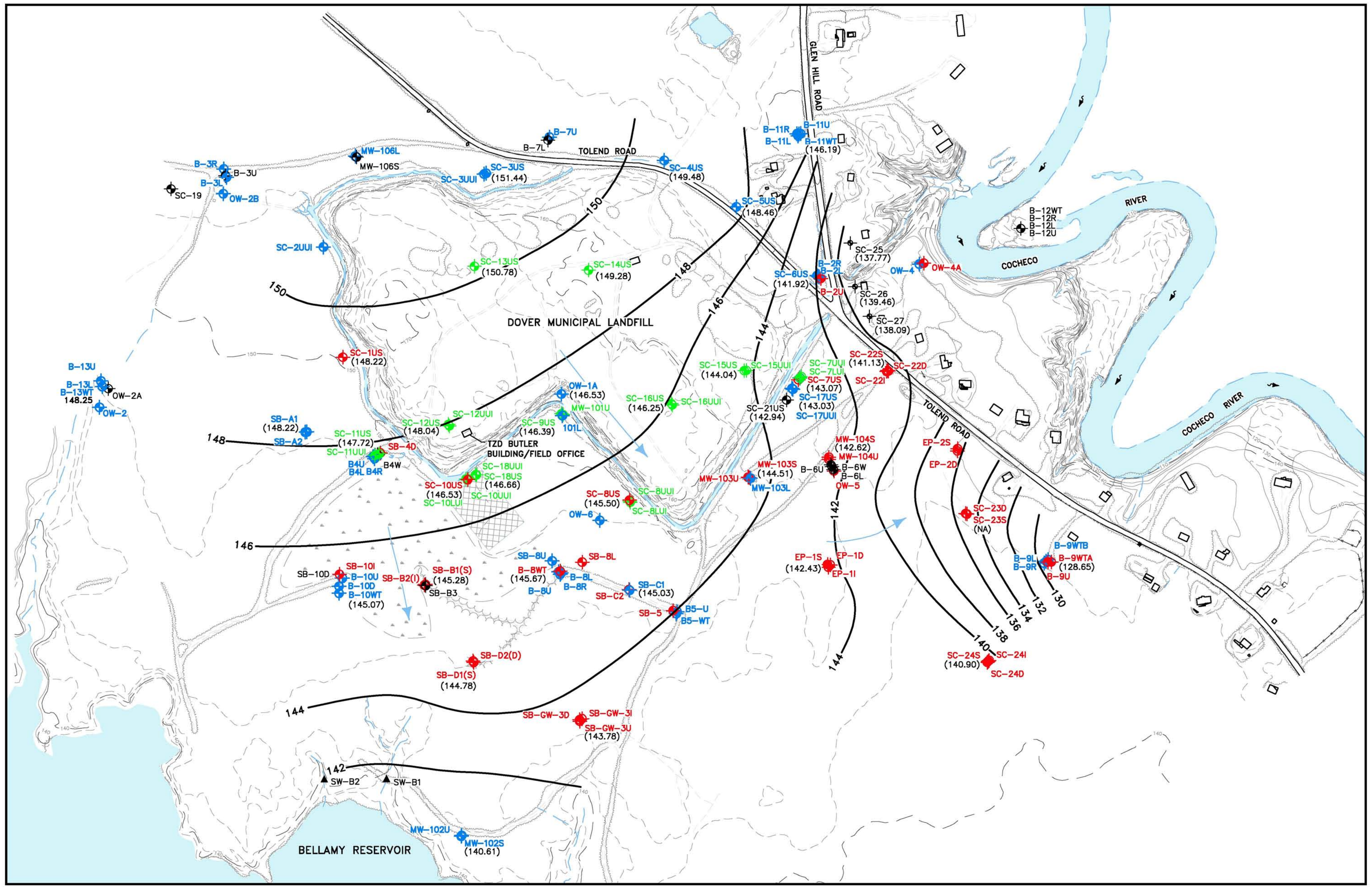
screened within the Landfill refuse. Because of the thickness of the refuse, depth to ground water in Landfill wells is generally 10 to 20 feet below grade. Seasonal fluctuations of ground water elevations are typically less than 5 feet. The lowest ground water elevations generally occur in late summer and early autumn, and the highest ground water elevations generally occur during the winter and early spring months.

Hydraulic information collected in and around the Landfill has been used to characterize the direction of ground water flow at the Site. The results of historical hydraulic characterization activities were summarized in Section 5 of Golder's 1995 PDI report, Section 4 of SEA's 1994 PDI report, Attachment A (Updated Hydrogeologic Information) to GeoInsight's May 1996 letter to the USEPA, and TZD's Technical Memorandum – Issues Summary titled "Ground Water Flow Direction" dated August 2000 (and presented and discussed during the September 2000 bioremediation pilot project meeting with the agencies). The results of these characterization activities are briefly summarized in this section.

With regard to regional flow patterns and regional ground water and surface water discharge locations (i.e., the Bellamy Reservoir and the Cocheco River), the direction of ground water flow is generally consistent within the US, UUI, and LUI strata. In the central and east portions of the Site, the general direction of ground water flow is to the south (within the Landfill footprint) and east toward the Cocheco River. In the west portion of the Site, the general direction of ground water flow is to the south toward the area north of the Bellamy Reservoir. A ground water flow divide that separates these two general flow patterns is located near the western border of the Landfill. In the US and UUI strata, the divide extends from the southwest corner of the Landfill to the south into the adjacent area of undeveloped forested wetlands (in the general direction of well couplet SB-GW-3). In the LUI stratum, the ground water divide appears to be located farther to the west, so that a greater percentage of flow within the LUI is to the east toward the Cocheco River than in the overlying two strata. Ground water contour maps for US, UUI, and LUI units based upon 2000 hydraulic data are included as Figures 1-8A through 1-8C.



DECEMBER 2000

LEGEND

SC-25	SENTINEL WELL SAMPLING LOCATION AND DESIGNATION
SC-7US	EMP WELL SAMPLING LOCATION AND DESIGNATION
SC-7UUI	ADDITIONAL WELL SAMPLING LOCATION AND DESIGNATION (DECEMBER 1995 TO PRESENT)
MW-17US	WELL LOCATIONS WHERE EMP WATER LEVELS ARE OBTAINED (IE, EMP SAMPLING IS NOT PERFORMED)
OW-2	WELL LOCATIONS WHERE WATER LEVELS ARE NOT OBTAINED AND SAMPLING IS NOT PERFORMED
SW-A	EMP SURFACE WATER SAMPLING LOCATION.
150	EXISTING TOPOGRAPHIC CONTOUR
	PAVED ROAD
	UNPAVED ROAD OR DRIVE
	TREATMENT ZONE
84	GROUND WATER CONTOUR (DASHED WHERE INFERRED)
	INFERRED DIRECTION OF GROUND WATER FLOW
(140.39)	GROUND WATER ELEVATION

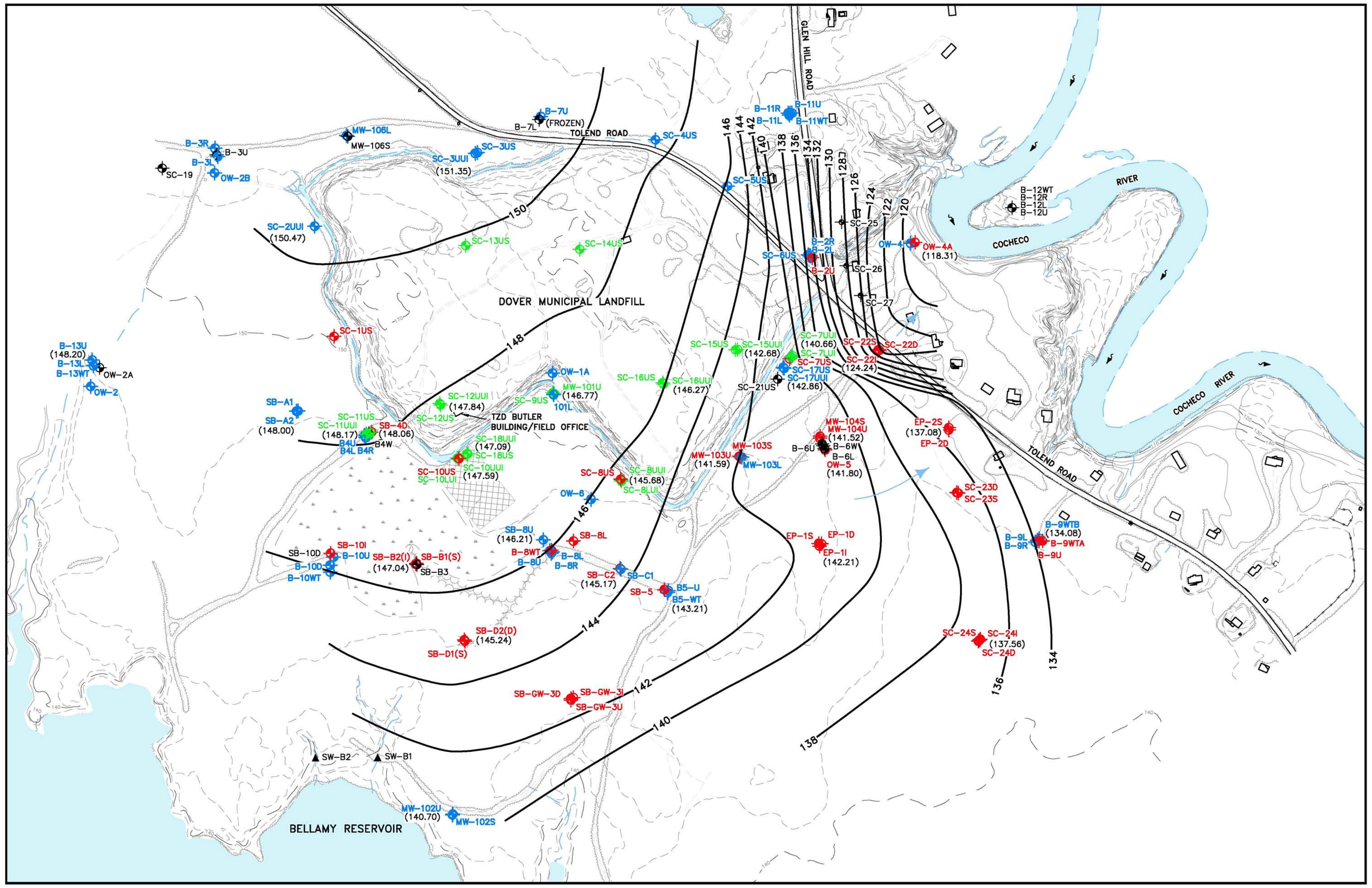
NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.
2. HISTORICAL FIGURE; BASE MAP NOT UPDATED.

DRAFT

0 300 600
APPROX. SCALE IN FEET

CLIENT: DOVER GROUP				GeoInsight Practical in Nature
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE				
TITLE: US UNIT, GROUND WATER CONTOUR MAP, DECEMBER 2000				
DESIGNED: KEZ	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW	
SCALE: 1" = 300'	DATE: 1/30/08	FILE NO.: 2009D136	PROJECT NO.: 2009-009	FIGURE NO.: 1-8A



DECEMBER 2000

LEGEND

SC-25	SENTINEL WELL SAMPLING LOCATION AND DESIGNATION
SC-7US	EMP WELL SAMPLING LOCATION AND DESIGNATION
SC-7UUI	ADDITIONAL WELL SAMPLING LOCATION AND DESIGNATION (DECEMBER 1995 TO PRESENT)
MW-17US	WELL LOCATIONS WHERE EMP WATER LEVELS ARE OBTAINED (IE, EMP SAMPLING IS NOT PERFORMED)
OW-2	WELL LOCATIONS WHERE WATER LEVELS ARE NOT OBTAINED AND SAMPLING IS NOT PERFORMED
SW-A	EMP SURFACE WATER SAMPLING LOCATION
150	EXISTING TOPOGRAPHIC CONTOUR
	PAVED ROAD
	UNPAVED ROAD OR DRIVE
	TREATMENT ZONE
84	GROUND WATER CONTOUR (DASHED WHERE INFERRED)
	INFERRED DIRECTION OF GROUND WATER FLOW
(140.39)	GROUND WATER ELEVATION

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.
2. HISTORICAL FIGURE; BASE MAP NOT UPDATED.

DRAFT

0 300 600
APPROX. SCALE IN FEET

CLIENT: DOVER GROUP			
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE			
TITLE: UUI UNIT, GROUND WATER CONTOUR MAP – DECEMBER 2000			
DESIGNED: KEZ	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW
SCALE: 1" = 300'	DATE: 1/30/08	FILE NO.: 2009D137	PROJECT NO.: 2009-009

FIGURE NO.: 1–8B

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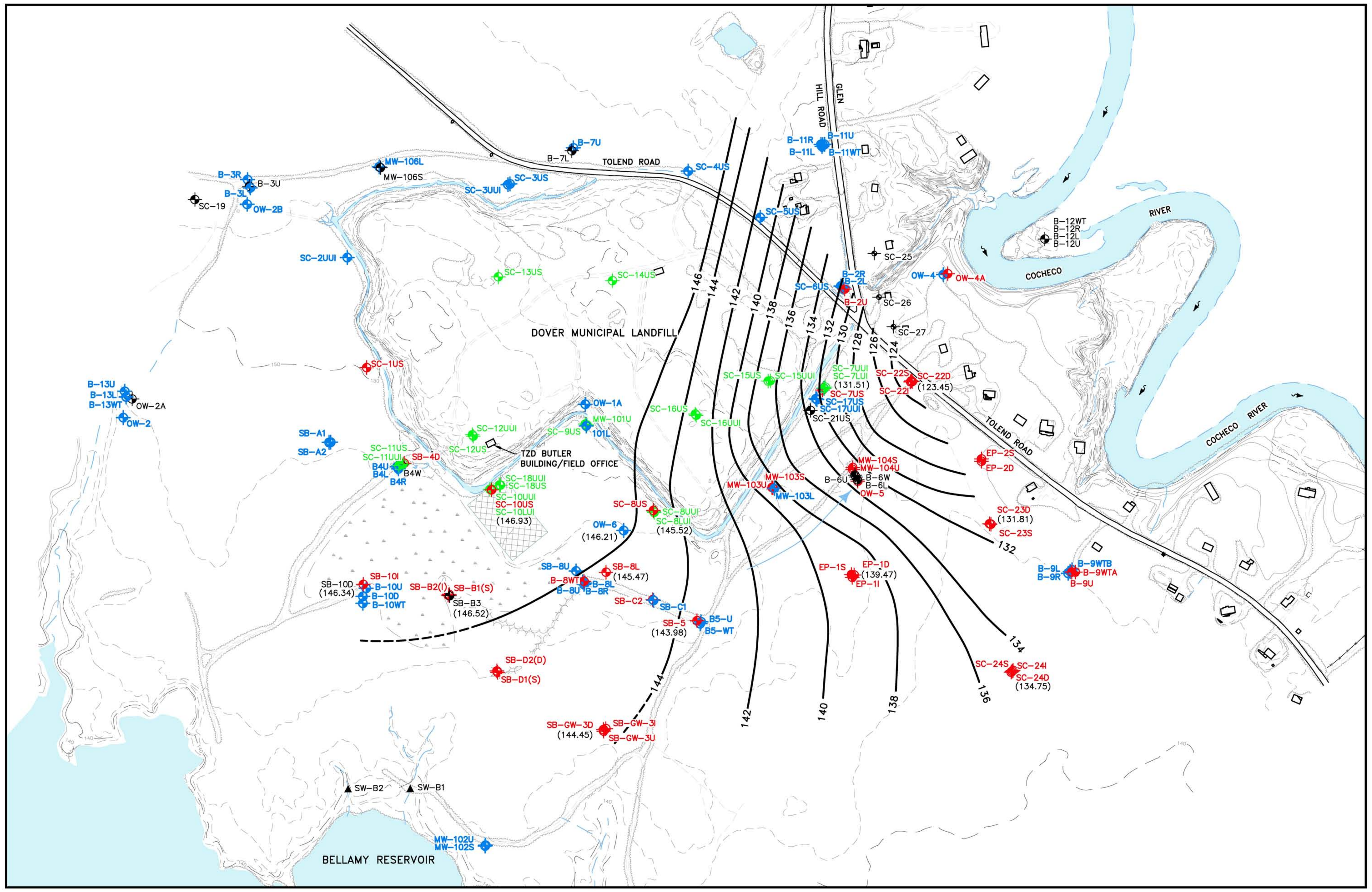


DECEMBER 2000

LEGEND

SC-25	SENTINEL WELL SAMPLING LOCATION AND DESIGNATION
SC-7US	EMP WELL SAMPLING LOCATION AND DESIGNATION.
SC-7UUI	ADDITIONAL WELL SAMPLING LOCATION AND DESIGNATION. (DECEMBER 1995 TO PRESENT)
MW-17US	WELL LOCATIONS WHERE EMP WATER LEVELS ARE OBTAINED (IE, EMP SAMPLING IS NOT PERFORMED).
OW-2	WELL LOCATIONS WHERE WATER LEVELS ARE NOT OBTAINED AND SAMPLING IS NOT PERFORMED.
SW-A	EMP SURFACE WATER SAMPLING LOCATION.
150	EXISTING TOPOGRAPHIC CONTOUR
	PAVED ROAD
	UNPAVED ROAD OR DRIVE
	TREATMENT ZONE
84	GROUND WATER CONTOUR (DASHED WHERE INFERRED)
	INFERRED DIRECTION OF GROUND WATER FLOW
(140.39)	GROUND WATER ELEVATION

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.
2. HISTORICAL FIGURE; BASE MAP NOT UPDATED.

DRAFT

0 300 600
APPROX. SCALE IN FEET

CLIENT: DOVER GROUP				GeoInsight Practical in Nature
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE				
TITLE: LUI UNIT, GROUND WATER CONTOUR MAP – DECEMBER, 2000				
DESIGNED: KEZ	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW	
SCALE: 1" = 300'	DATE: 1/31/08	FILE NO.: 2009D152	PROJECT NO.: 2009-009	FIGURE NO.: 1–8C

In the Southern Plume Study Area, the main portion of the VOC plume appears to extend southward from the toe of the Landfill and then trends eastward in the area of well SB-B2 (see Figure 4 from the Southern Plume PDI Report [GeoInsight, 2007] in Appendix C).

Figure 4 illustrates the extent of dissolved VOC impacts by stratum and suggests different flow patterns for the US and UUI units. Flow within the UUI unit, based upon mapping of dissolved concentrations, appears to be oriented more easterly than southerly. Flow hydraulics in this area are currently being further evaluated as part of Phase II of the Southern Plume PDI.

1.4.8.4 Ground Water Gradients and Seepage Velocities

Ground water gradients and seepage velocities were summarized in the 2004 RFFS (Section 1.3.4.3, pages 1-52 to 1-57). Additional evaluations related to ground water gradients and seepage velocities have not been performed since the 2004 RFFS was prepared. Estimated values for ground water gradients and seepage velocities are presented in Tables 1-2, 1-3, and 1-4, which were prepared for the 2004 RFFS. References and supporting documentation are included in the 2004 RFFS.

In general, the following conditions were summarized in the 2004 RFFS:

- horizontal gradients in the US unit range between 0.003 and 0.005 feet/foot (ft/ft);
- horizontal gradients in the UUI unit range between 0.002 and 0.005 ft/ft;
- horizontal gradients in the US unit and the UUI unit are similar in both the eastern and western portions of the Landfill and become steeper toward the Cocheco River, east of the Landfill;
- the horizontal gradients in the LUI unit range between 0.002 and 0.004 ft/ft in the western portion of the Landfill and between 0.01 and 0.02 ft/ft in the eastern portion of the Landfill;
- the horizontal gradients within the three stratigraphic units are generally consistent throughout the period of available data (1993 through 2002);

TABLE 1-2
SUMMARY OF HORIZONTAL HYDRAULIC GRADIENT DATA
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

Upper Sand Unit	Oct-93	Dec-93	Apr-94	Aug-94	Jan-95	May-95	Sep-95	Nov-95	Mar-96	Average
East side of landfill	0.005	0.004	0.005	0.005	0.004	0.004	0.005	0.005	0.005	0.005
West side of landfill	0.004	0.003	0.004	0.005	0.004	0.003	0.004	0.004	0.004	0.004
Upper Upper Interbedded Unit										
East side of landfill	0.005	0.004	0.004	0.005	0.004	0.004	0.005	0.004	0.004	0.004
West side of landfill	0.003	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Lower Upper Interbedded Unit										
East side of landfill	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02
West side of landfill	0.002	0.002	0.002	0.003	0.002	0.002	0.004	0.002	0.003	0.002

Notes:
1. Hydraulic gradients reported in feet/foot.

TABLE 1-3
SUMMARY OF GROUND WATER SEEPAGE VELOCITIES
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

Upper Sand Unit	Oct-93	Dec-93	Apr-94	Aug-94	Jan-95	May-95	Sep-95	Nov-95	Mar-96	Average
East side of landfill	1.0 ft/day	0.8 ft/day	1.0 ft/day	0.8 ft/day	0.8 ft/day	0.8 ft/day	1.0 ft/day	1.0 ft/day	1.0 ft/day	0.9 ft/day
West side of landfill	0.5 ft/day	0.4 ft/day	0.5 ft/day	0.6 ft/day	0.5 ft/day	0.4 ft/day	0.5 ft/day	0.5 ft/day	0.5 ft/day	0.5 ft/day
Upper Upper Interbedded Unit										
East side of landfill	0.4 ft/day	0.3 ft/day	0.4 ft/day	0.4 ft/day	0.3 ft/day	0.3 ft/day	0.4 ft/day	0.3 ft/day	0.3 ft/day	0.3 ft/day
West side of landfill	0.2 ft/day	0.1 ft/day	0.1 ft/day	0.2 ft/day	0.2 ft/day	0.2 ft/day	0.2 ft/day	0.2 ft/day	0.2 ft/day	0.2 ft/day
Lower Upper Interbedded Unit										
East side of landfill	0.2 ft/day	0.3 ft/day	0.3 ft/day	0.3 ft/day	0.2 ft/day	0.3 ft/day	0.3 ft/day	0.3 ft/day	0.3 ft/day	0.3 ft/day
West side of landfill	0.08ft/day	0.08ft/day	0.08ft/day	0.1 ft/day	0.08ft/day	0.08ft/day	0.2 ft/day	0.08ft/day	0.1 ft/day	0.1 ft/day

Notes:
1. Hydraulic conductivities used in calculating seepage velocities obtained from pump test data in Pre-Design Report (Golder, February 1995).
2. Effective porosities used in calculating seepage velocities obtained from Pre-Design Report.

TABLE 1-4
SUMMARY OF VERTICAL HYDRAULIC GRADIENT DATA
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

Well Couplet	Hydrogeologic Units	Screen Interval	Oct-93	Dec-93	Apr-94	Aug-94	Jan-95	May-95	Sep-95	Nov-95	Mar-96
Eastern side of Site											
SC-7US/SC-7UUI	US/UUI	10-25/29-34	0.06	1.2[2]	0.1	0.2	0.2	0.02	0.1	0.8	0.1
SC-7UUI/SC-7LUI	UUI/LUI	29-34/56-61	0.4	-0.2[2]	0.5	0.3	0.4	0.04	0.3	-0.02	0.4
SC-15US/SC-15UUI	US/UUI	27-32/37-42	0.09	0.2	0.1	0.2	0.2	0.1	0.09	0.1	0.04
SC-16US/SC-16UUI	US/UUI	28-33/38-43	-0.02	0	-0.008	-0.02	0.006	-0.04	-0.03	0.007	-0.007
SC-17US/SC-17UUI	US/UUI	20-25/30-35	0.05	-1.1[2]	0.05	0.04	0.06	0.06	0.04	0.05	0.05
MW-103S/MW-103U	US/UUI	14-19/41.5-46.5	0.1	0.1	0.09	0.1	0.1	0.1	0.09	0.09	0.09
MW-104S/MW-104U	US/UUI	15-20/31-36	0.08	0.09	0.06	0.08	0.07	0.07	0.07	0.05	0.04
EP-1S/EP-1L	US/MUI	6-16/26-36	-0.02	0.02	-0.007	-0.02	0.007	0.002	0.002	-0.002	No Data
EP-1L/EP-1D	MUI/LUI	26-36/50-60	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	No Data
EP-2S/EP-2D	MUI/LUI	16-26/26-36	0.3	0.5	0.5	0.4	0.5	0.5	0.4	0.5	0.05
Western side of site											
SC-9US/MW-101U	US/UUI	20-25/32.5-37.5	0.005	-0.02	-0.05	-0.002	-0.03	-0.03	0.002	-0.06	-0.04
SC-8US/SC-8UUI	US/UUI	9-14/33-38	-0.01	-0.01	-0.03	-0.008	-0.02	-0.02	-0.01	-0.08	0.01
SC-8UUI/SC-8LUI	UUI/LUI	33-38/41-46	0.03	0.03	0.03	0.04	0.03	0.02	0.04	0.02	-0.1
SC-10US/SC-10UUI	US/UUI	5-20/24-29	-0.05	-0.03	-0.05	-0.06	-0.04	-0.04	-0.09	-0.07	-0.06
SC-10UUI/SC-10LUI	UUI/LUI	24-29/43-48	-0.01	0.02	0.01	0.003	0.02	0.03	-0.001	0.01	0.01
SC-11US/SC-11UUI	US/UUI	4.5-9.5/16-21	-0.03	-0.009	-0.04	-0.04	-0.03	-0.02	0.04	-0.06	No Data
SC-12US/SC-12UUI	US/UUI	34-39/44-49	0.007	0.01	0.01	0.01	0.008	0.01	0.01	0.01	0.01
SC-18US/SC-18UUI	US/UUI	14-19/24-29	-0.05	-0.04	-0.06	-0.05	-0.05	-0.04	-0.07	-0.07	-0.06
B-10WT/SB-10	US/LUI	1.7-11.6/54-64	-0.03	-0.02	-0.006	-0.04	No Data	-0.02	-0.04	-0.03	No Data
SB-B1/SB-B2	US-UUI/MUI	5-15/34-44	-0.08	-0.06	-0.07	-0.2	No data	-0.06	-0.1	-0.07	No Data
SB-B2/SB-B3	MUI/LUI	34-44/47-57	0.03	0.04	0.04	0.1	No data	0.05	0.03	0.05	No Data
SB-D1/SB-D2	US/LUI	5-15/50-60	-0.04	0.009	-0.01	-0.05	-0.01	-0.008	-0.05	-0.02	0.007

Notes:
1. Minus sign (-) denotes upward vertical gradient.
2. Well SC-7UUI pumping at 0.85 gallons per minute.
3. US = Upper sand unit.
4. UUI = Upper portion of upper interbedded unit.
5. MUI = Middle portion of upper interbedded unit.
6. LUI = Lower portion of upper interbedded unit.
7. Screen interval in feet below ground surface.

- the horizontal hydraulic gradients observed within the LUI unit in the eastern portion of the Site are one order of magnitude greater than horizontal hydraulic gradients measured in the three stratigraphic units elsewhere at the Site;

- the seepage velocities in the US unit range between 0.4 and 1.0 foot per day (ft/day);

- the seepage velocities in the UUI unit range between 0.1 and 0.4 ft/day;

- the seepage velocities in the LUI unit range between 0.08 and 0.3 ft/day;

- the horizontal hydraulic gradients are relatively consistent within each stratigraphic unit over time;

- vertical gradients were consistent throughout the period of data acquisition (1993 through 2002); however, in some instances the direction of vertical flow changed periodically;

- upward vertical gradients range between 0.001 and 0.09 ft/ft between the US and UUI units to the south and southwest of the western portion of the Landfill;

- data suggest that shallow ground water downgradient of the western portion of the Landfill is discharging to the forested wetlands between the Landfill and the Bellamy Reservoir;

- downward vertical gradients range between 0.003 and 0.05 ft/ft between the UUI and LUI units to the south of the western portion of the Landfill, although the direction of flow was upward during several monitoring events;

- in the eastern portion of the Landfill, vertical flow is generally downward between both the US and UUI units and the UUI and LUI units; and

- downward vertical gradients in the eastern portion of the Landfill range between 0.04 and 0.8 ft/ft. These data suggest a downward movement of ground water toward the Cocheco River.

1.4.8.5 Surface Water Flow Features

Surface water features in the vicinity of the Site include the perimeter ditch, the drainage swale, the Cocheco River, and the Bellamy Reservoir. These features are shown on Figure 1-5. A surface water divide between the Bellamy Reservoir drainage basin (to the south) and the Cocheco River drainage basin (to the east) trends northwest to southeast and generally bisects the western portion of the Landfill. However, the perimeter ditch intercepts shallow ground water and surface water runoff from the Landfill and diverts it to the Cocheco River via the drainage swale. In addition, forested wetlands are located to the north, northwest, west, south, and southeast of the Landfill. The general direction of surface water drainage within these wetland areas, as characterized during the 1995 Golder PDI, are indicated on Figure 1-4 (Figure 2-7 and Sections 2.3.3 [page 24] and 2.3.5 [page 30] of Golder February 1995 PDI report).

1.4.9 Current Ground Water Quality Conditions

1.4.9.1 Overview

Since the 1991 ROD was issued, ground water monitoring events have been performed in 1993 (five events) and semi-annually during the period of 1994 through 2006 in accordance with the EMP. See Section 1.4.4 for a summary of wells monitored under the EMP program.

Samples collected during the EMP events have been analyzed for field parameters and VOCs. Analysis of semi-volatile organic compounds (SVOCs) has been performed biannually (in 1995, 1997, 1999, and 2001). From 1993 to 1999, EMP samples were also analyzed for a number of inorganic constituents, including arsenic, calcium, iron, manganese, magnesium, potassium, and sodium. Starting in 2000, the suite of inorganic parameters was reduced to total and dissolved arsenic, iron, and manganese. Samples from the additional wells monitored concurrently with the EMP wells and the sentinel wells have been analyzed for VOCs, field parameters, and samples from certain wells (i.e., wells within the Landfill and along the Landfill toe) have also been analyzed for total and dissolved iron, arsenic, and manganese.

The historical EMP data indicate that the leachate plume generated by the Landfill is characterized by the following conditions:

- reducing geochemical conditions (i.e., below 1 milligram per liter [mg/L] of dissolved oxygen [DO]);

- elevated concentrations (several thousand to tens of thousands µg/L) of dissolved iron and manganese;
- elevated concentrations (tens to several hundred µg/L) of dissolved arsenic, with the higher concentrations detected downgradient of the oldest (eastern) portion of the Landfill;
- specific conductivity values typically above 1 milli-Siemen per centimeter (mS/cm);
- generally low concentrations (tens to several hundreds of µg/L) of petroleum VOCs, including BTEX;
- very low concentrations (single digit to several tens of µg/L) of chlorinated hydrocarbons, most frequently including PCE, TCE, cDCE, and VC; and
- localized presence (typically near the most recently filled portion of the Landfill) of THF, MIBK, and MEK at concentrations ranging from tens to several thousand µg/L (typically the higher concentrations are THF alone).

The sections that follow provide a brief summary of current ground water conditions in the interior and at the toe of the Landfill because an updated discussion of conditions in these areas is relevant to the SC remedy evaluation. Tables that summarize the historical ground water quality results for the individual wells at the Site are included in Appendix B.

1.4.9.2 Delineation of Ground Water Impacts

1.4.9.2.1 Landfill Interior

Additional information related to the magnitude and distribution of ground water impacts within the interior of the Landfill was obtained during the Northwest Landfill and the Air Sparging Trench PDIs. During these investigations, ground water was collected utilizing direct push, discrete sampling methods and not from standard monitoring wells; therefore, results were not compared to ICLs. Results were used instead to identify the general extent of impacts to ground water.

Phase I Northwest Landfill PDI investigation activities identified an area within the north portion of the Landfill that contained elevated concentrations of VOCs. This area was observed to extend to the northeast and discharge to the north perimeter ditch approximately 450 feet west of the culvert at EMP surface water sampling Station SW-E. The area of VOC impacts was observed to be roughly elliptical in shape and comprised of two roughly coincident hotspots, representing different suites of constituents. Figure 3B from the Northwest Landfill Summary Report depicting these hotspots is included in Appendix C. The smaller hotspot was located closer to the ditch and was characterized by elevated concentrations of PCE, TCE, cDCE, and VC. The second hotspot appeared to extend over a larger area; consists primarily of toluene, MEK, MIBK, and methylene chloride; and extends farther south into the Landfill. Figure 6 of the Northwest Landfill Summary Report (included in Appendix C) presents the laboratory results for these four compounds identified in the second hotspot. The suite of VOCs that were detected within these coincident hotspots is similar to the suite of VOCs detected in surface water samples collected from the north portion of the perimeter ditch (see Section 1.4.7). Concentrations of chlorinated ethenes were identified up to hundreds of thousands μg/L, toluene was identified in the tens of thousands μg/L, aromatic hydrocarbons were identified in the hundreds to thousands μg/L, and THF was identified up to thousands μg/L (Table 8 of the Phase I PDI Northwest Landfill Summary Report, GeoInsight 2006).

The VOCs appeared to be primarily located in shallow ground water within the Study Area and not in deeper ground water. These data suggest that at the perimeter ditch, the VOCs discharge to surface water via horizontal migration of shallow ground water, as opposed to the vertical upward migration of deeper ground water. Deeper impacts to ground water in the UUI unit appeared to be located to the south of the shallow hotspot (see Figures 5A, 5B, 5C, and 5D in NW Landfill Summary Report, December 2006 included in Appendix C).

Phase I Air Sparge Trench PDI investigation activities further delineated impacts to ground water within the footprint of the Landfill. As described in Section 1.4.6 of this report, ground water samples were collected from vertical profiles at 33 locations distributed across the entire Landfill, with the exception of the Northwest Landfill hotspot area. Laboratory analytical data are summarized in Table 1-5.

Impacts to ground water were identified by the Trench PDI primarily in the western portion of the Landfill, just south of the Northwest Landfill hotspot described above. Additional impacted hotspots were not identified during the Trench PDI Phase I activities. The dissolved plume of impacts is characterized by elevated concentrations (i.e., above ICLs) of benzene, VC, and THF in the hundreds to thousands μg/L. Data collected during Phase I of the Air Sparge Trench PDI for benzene, VC, and THF are illustrated on Figures 1-9A, 1-9B, and 1-9C, respectively. The suite of VOCs detected within the plume on the western side of the Landfill was similar to the suite of VOCs detected in the Northwest Landfill hotspot. Within the area investigated by XDD, the highest concentrations of COCs were identified in borings GW-29, GW-30, GW-32, and GW-33 located in the western lobe of the Landfill. The highest concentrations of benzene, VC, and THF in these four borings were 63 μg/L (GW-30), 9 μg/L (GW-33), and 5,500 μg/L (GW-32), respectively.

THF impacts to ground water are primarily located in the western lobe of the Landfill. VC- and benzene-impacted ground water was present in isolated areas across the Landfill; however, the magnitudes of these impacts were comparatively much lower than the THF impacts on the western side of the Landfill (typically below 100 ug/L as compared to levels of THF of 1,000 ug/L or more) and did not indicate the presence of other hotspots. One area of elevated VC concentrations was identified at location GW-21 where the concentration of VC was measured at 440 ug/L between 28 and 30 feet BGS. Data from other locations evaluated in the interior of the Landfill that generally indicated VC concentrations in the tens of ug/L in ground water included locations GW-8, GW-9, GW-16, GW-19, and GW-27. Concentrations of benzene in ground water were typically detected at single digits to tens of ug/L across the Landfill. During the Air Sparge Trench PDI, locations where the concentration of benzene was between 100 and 130 ug/L included GW-04, GW-05, GW-06, GW-13. These locations were in the southern portion of the eastern lobe of the Landfill and, except for GW-13, were located at the Landfill toe (see Section 1.4.9.2.2 for a discussion of ground water quality at the Landfill toe).

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 1 of 2
Dover Municipal Landfill Superfund Site
Dover, New Hampshire

Boring	Depth Below Grade (ft)	Benzene	Ethyl-benzene	Toluene	Total Xylenes	PCE	TCE	cis-1,2-DCE	Vinyl Chloride	Acetone	Tetrahydro-furan	2-Butanone	4-Methyl 2-Pentanone	Methylene-Chloride	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Bromo-methane	Chloro-methane	Chloro-form	Dibromo-chloro-methane
GW-01																						
	08-10	5	1 U	0.4 J	3 U	1 U	1 U	0.4 J	2 U	5	15	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	**18**	2	0.6 J	3 U	1 U	1 U	1 U	2	5 U	6	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**42**	38	41	40	1 U	1	6	**6**	3 J	3 J	5 U	5 U	2 J	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**16**	38	1	2 J	1 U	1 U	3	**9**	4 J	11	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**6**	12	0.6 J	1 J	1 U	0.6 J	7	**8**	3 J	24	5 U	5 U	5 U	1 U	0.6 J	1 U	1	2 U	2 U	1 U	1 U
	38-40	1 U	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	0.5 J	1 U	1 U	3 U	1 U	1 U	1 U	2 U	23	5 U	4 J	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
GW-02																						
	08-10	2	1 U	1 U	3 U	1 U	1 U	1 U	2 U	7	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	**11**	1 U	1 U	2 J	1 U	1 U	1 U	2 U	6	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**38**	1 U	0.4 J	3 U	1 U	1 U	1 U	**4**	6	4 J	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**57**	50	56	84	1 U	**6**	5	**10**	12	4 J	5 U	5 U	**13**	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**33**	56	4	110	1 U	2	11	**20**	4 J	26	5 U	5 U	5 U	1 U	0.9 J	1 U	2	2 U	2 U	1 U	1 U
	38-40	**22**	63	4	120	1 U	0.8 J	11	**24**	5 U	62	5 U	5 U	5 U	1 U	2	1 U	3	2 U	2 U	1 U	1 U
	48-50	1 U	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	58-60	1 U	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
GW-03																						
	08-10	3	1 U	0.4 J	0.6 J	1 U	1 U	1	**3**	7	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	3	0.8 J	1	3	1 U	1 U	1 U	0.5 J	6	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	5	3	0.9 J	7	1 U	1 U	1 U	2 U	7	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**12**	4	0.6 J	1 J	1 U	1 U	0.5 J	**8**	8	5 J	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**57**	39	66	130	1 U	1 U	12	**18**	5	8	5 U	5 U	1 J	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**57**	71	7	220	1 U	4	17	**27**	17	49	5 U	5 U	0.4 J	1 U	1	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	1	2	2	2 J	1 U	1 U	0.4 J	1 J	5 U	3 J	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	58-60	1 U	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
GW-04																						
	08-10	5	1 U	1	28	1 U	1 U	1 U	2 U	5 J	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	**10**	4	0.5 J	36	1 U	1 U	1 U	2 U	9	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**14**	13	1 U	22	1 U	1 U	1 U	2 U	7	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**39**	1 U	0.6 J	3 U	1 U	1 U	1 U	**3**	3 J	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**130**	23	6	48	1 U	1 U	1 U	**16**	5 U	8	5 U	5 U	0.8 J	1 U	0.7 J	1 U	2	2 U	2 U	1 U	1 U
	38-40	**71**	89	8	260	1 U	1	4	**15**	5 U	7	5 U	5 U	0.5 J	1 U	1 U	1 U	2	2 U	2 U	1 U	1 U
	48-50	**21**	57	2	270	1 U	1 U	4	**20**	9	29	5 U	5 U	5 U	1 U	5	1 U	1 U	2 U	2 U	1 U	1 U
	58-60	1 U	1 U	2	3 U	1 U	1 U	1 U	2 U	3 J	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
GW-05																						
	08-10	**26**	1 U	0.8 J	140	1 U	1 U	1 U	**6**	5 U	10	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	**10**	1 U	0.3 J	63	1 U	1 U	1 U	2 U	4 J	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**24**	14	1	86	1 U	1 U	1 U	0.9 J	5 J	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**76**	74	2	260	1 U	1 U	1 U	**3**	7	5 U	5 U	5 U	5 U	1 U	0.8 J	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**85**	67	8	230	1 U	2	2	**15**	6	12	5 U	6	**8**	1 U	2	1 U	2	2 U	2 U	1 U	1 U
	38-40	**100**	62	8	220	1 U	**6**	10	**23**	8	12	5 U	5 U	**15**	1 U	2	1 U	3	2 U	2 U	1 U	1 U
	48-50	**40**	32	2	8	1 U	1 U	0.6 J	**7**	6	60	5 U	5 U	0.5 J	1 U	3	1 U	2	2 U	2 U	1 U	1 U
	58-60	**6**	1	1	3 U	1 U	1 U	2	**11**	5 U	15	5 U	4 J	5 J	1 U	2	1 U	0.3 J	2 U	2 U	1 U	1 U
ICL (ug/L):		**5**	**700**	**1,000**	**10,000**	**5**	**5**	**70**	**2**	**700**	**154**	**200**	**350**	**5**	**200**	**81**	**7**	**5**	**10**	**3**	**---**	**---**

Concentrations reported in ug/L (ppb).

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 1 of 2
Dover Municipal Landfill Superfund Site
Dover, New Hampshire

Boring	Depth Below Grade (ft)	Benzene	Ethyl-benzene	Toluene	Total Xylenes	PCE	TCE	cis-1,2-DCE	Vinyl Chloride	Acetone	Tetrahydro-furan	2-Butanone	4-Methyl 2-Pentanone	Methylene-Chloride	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Bromo-methane	Chloro-methane	Chloro-form	Dibromo-chloro-methane
GW-06																						
	08-10	**10**	2	0.4 J	2 J	1 U	1 U	1 U	2 U	22	36	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	**130**	180	4	790	1 U	1 U	1 U	2 U	5 U	45	5 U	5 U	0.6 J	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**50**	67	2	470	1 U	1 U	1 U	**15**	18	4 J	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**28**	13	0.9 J	220	1 U	1 U	1 U	**20**	16	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**55**	64	4	220	1 U	1 U	1 U	2 U	21	52	5 U	5 U	0.4 J	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**13**	0.7 J	1 U	3 U	1 U	1 U	0.6 J	2 U	13	25	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	**24**	0.7 J	0.4 J	0.6 J	1 U	1 U	6	**7**	17	72	5 U	5 U	3 J	1 U	1	1 U	1 U	2 U	2 U	1 U	1 U
	58-60	**26**	2	2	7	1 U	1 U	25	**55**	12	110	5 U	5 U	**6**	1 U	8	1 U	4	2 U	2 U	1 U	1 U
GW-07																						
	08-10	**10**	5	0.4 J	28	1 U	1 U	0.7 J	2 U	15	36	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	**8**	1 U	1 U	3 U	1 U	1 U	1 U	2 U	20	53	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 UJ	2 UJ	1 U	1 U
	23-25	**12**	1 U	0.3 J	3 U	1 U	1 U	1 U	2 U	6	10	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**65**	23	2	190	1 U	1 U	0.5 J	2 U	18	10	2 J	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**27**	44	1	130	1 U	1 U	1 U	2 U	8	55	2 J	5 U	5 U	1 U	0.6 J	1 U	0.8 J	2 U	2 U	1 U	1 U
	38-40	**9**	0.5 J	0.3 J	3 U	1 U	1 U	1	1 J	6	33	5 U	5 U	5 U	1 U	0.4 J	1 U	0.7 J	2 U	2 U	1 U	1 U
	48-50	**20**	5	3	22	1 U	1 U	8	**15**	4 J	83	5 U	77	1 J	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
	58-60	**9**	6	3	5	1 U	1 U	6	**45**	8	41	5 U	5 U	4 J	1 U	7	1 U	1 U	2 U	2 U	1 U	1 U
GW-08																						
	18-20	3	5	4	16	1 U	1 U	0.5 J	2 U	6	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	5	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**84**	95	4	10	1 U	1 U	1 U	**12**	12	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**47**	42	20	110	2	2	4	**7**	13	5 U	5 U	5 U	3 J	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**12 J**	39 J	1 J	31 J	1 U	1 U	2 J	**8 J**	16 J	7 J	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	**10**	20	2	15	3	0.6 J	5	**12**	7	5 U	5 U	5 U	0.4 JB	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	58-60	1 U	1 U	0.3 J	3 U	2	1 U	1 U	2 U	12	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	0.8 J	1 U
GW-09																						
	08-10	**28**	1 U	0.4 J	270	1 U	1 U	1 U	2 U	6	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	3	1 U	0.8 J	460	1 U	1 U	1 U	2 U	11	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	3	1 U	0.4 J	33	1 U	1 U	1 U	2 U	7	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**10**	3	0.6 J	33	1 U	1 U	1 U	2 U	8	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**34**	22	0.9 J	96	1 U	1 U	1 U	2 U	8	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**19**	0.7 J	1 U	1 J	1 U	1 U	0.4 J	2 U	8	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	**40**	99	3	330	1 U	1	6	**19**	12	64	5 U	5 U	0.8 J	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
	58-60	**8**	12	8	51	1 U	1 U	1 U	2 U	4 J	12	5 U	5 U	0.5 J	1 U	1	1 U	1 U	2 U	2 U	1 U	1 U
GW-10																						
	18-20	**43**	38	79	49	1 U	1 U	0.6 J	2 U	140	150	100	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**16**	1 U	0.6 J	17	1 U	1 U	1 U	2 U	8	6	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**70**	18	2	130	1 U	1 U	0.6 J	2 U	19	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**56**	17	3	210	1 U	1 U	1	**7**	25	6	3 J	5 U	5 U	1 U	1	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**35**	3	0.8 J	8	1 U	1 U	1	**4**	22	9	3 J	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	**36**	1 J	1	2 J	1 U	0.9 J	6	**22**	12	100	5 U	5 U	1 J	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
ICL (ug/L):		**5**	**700**	**1,000**	**10,000**	**5**	**5**	**70**	**2**	**700**	**154**	**200**	**350**	**5**	**200**	**81**	**7**	**5**	**10**	**3**	**---**	**---**

Concentrations reported in ug/L (ppb).

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 1 of 2
Dover Municipal Landfill Superfund Site
Dover, New Hampshire

Boring	Depth Below Grade (ft)	Benzene	Ethyl-benzene	Toluene	Total Xylenes	PCE	TCE	cis-1,2-DCE	Vinyl Chloride	Acetone	Tetrahydro-furan	2-Butanone	4-Methyl 2-Pentanone	Methylene-Chloride	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Bromo-methane	Chloro-methane	Chloro-form	Dibromo-chloro-methane
GW-11																						
	08-10	3	1 U	1 U	3	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	**8**	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**32**	81 J	1 U	180 J	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**33**	30	2	29	1 U	1 U	2	2 J	12	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	1	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	3	0.7 J	0.3 J	3 U	1 U	1 U	0.6 J	2 J	9	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	1 UJ	1 UJ	1 UJ	3 UJ	1 UJ	1 UJ	1 UJ	2 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	1 UJ	1 UJ	1 UJ	1 UJ	2 UJ	2 UJ	1 UJ	1 UJ
	58-60	1 U	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
GW-12																						
	08-10	3	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	5	1 U	0.9 J	1500	1 U	1 U	1 U	2 U	5	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	3	1 U	1 U	35	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	5	1	0.8 J	16	1 U	1 U	1 U	1 J	6	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**6**	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**29**	61	2	180	1 U	1 U	0.8 J	**4**	8	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	**20**	40	3	86	1 U	1 U	5	**12**	6	40	5 U	5 U	5 U	1 U	1	1 U	1 J	2 U	2 U	1 U	1 U
GW-13																						
	18-20	**130**	1 U	2	350	1 U	1 U	1 U	2 U	12	6	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**8**	1 U	8	110	1 U	1 U	1 U	2 U	8	5 U	5 U	5 U	5 U	1 U	1 J	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**11**	1 U	7	160	0.5 J	1 U	1 U	2 U	10	5 U	5 U	5 U	0.7 J	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**29**	28 J	9	190 J	1 U	1 U	1 U	2 U	11	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	43-45	**16**	26	3	110	1 U	1 U	1 U	2	10	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	58-60	**43**	78	20	430	2 U	2 U	2 U	4 U	35	30	6 J	10 U	4 J	2 U	2	2 U	2 U	4 U	4 U	2 U	2 U
GW-14																						
	18-20	**40**	49	1	70	1 U	1 U	1 U	0.4 J	8	7	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**46**	1 U	1	400	1 U	1 U	1 U	2 U	11	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**30**	2	0.7 J	200	1 U	1 U	1 U	0.6 J	6	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**21**	11	1	240	1 U	1 U	1 U	0.6 J	4 J	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**14**	1 U	0.8 J	170	1 U	1 U	0.4 J	0.8 J	11	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	**20**	19	1	44	1 U	1 U	1 U	**3**	10	40	2 J	5 U	0.4 J	1 U	2	1 U	2	2 U	2 U	1 U	1 U
GW-15																						
	08-10	1 U	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 B	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	4	1 U	0.4 J	3 U	1 U	1 U	1 U	2 U	4 JB	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**8**	1 U	1 U	76	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	5	1 U	0.7 J	38	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**24**	8	1 U	2 J	1 U	1 U	1 U	2 U	4 J	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**7**	1 U	1 U	1 J	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	1 U	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	58-60	1 U	1 U	1 U	1 J	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
ICL (ug/L):		**5**	**700**	**1,000**	**10,000**	**5**	**5**	**70**	**2**	**700**	**154**	**200**	**350**	**5**	**200**	**81**	**7**	**5**	**10**	**3**	**---**	**---**

Concentrations reported in ug/L (ppb).

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 1 of 2
Dover Municipal Landfill Superfund Site
Dover, New Hampshire

Boring	Depth Below Grade (ft)	Benzene	Ethyl-benzene	Toluene	Total Xylenes	PCE	TCE	cis-1,2-DCE	Vinyl Chloride	Acetone	Tetrahydro-furan	2-Butanone	4-Methyl 2-Pentanone	Methylene-Chloride	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Bromo-methane	Chloro-methane	Chloro-form	Dibromo-chloro-methane
GW-16																						
	18-20	2	1 U	1 U	25	1 U	1 U	1 U	2 U	6	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	5	1 U	0.3 J	7	1 U	1 U	1 U	2 U	9	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	10	1 U	1 U	62	1 U	1 U	1 U	2 U	5 UJ	5 UJ	5 UJ	5 UJ	5 U	1 U	1 U	1 U	1 UJ	2 UJ	2 U	1 UJ	1 UJ
	33-35	7	1 U	0.4 J	4	1 U	1 U	1 U	2 U	3 J	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	5	1 U	1 U	11	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	38	160	16	700	1 U	1 U	28	32	6	93 B	2 J	5 U	5 U	1 U	1	1 U	4	2 U	2 U	1 U	1 U
	58-60	29	140	10	700	1 U	1 U	42	48	10	180 B	3 J	5 U	1 J	1 U	4	1 U	4	2 U	2 U	1 U	1 U
	68-70	2	1 U	0.4 J	4	1 U	1 U	0.5 J	2 U	3 J	17 B	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
GW-17																						
	18-20	24	59	0.5 J	1100	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	20	1 U	0.9 J	760	1 U	1 U	1 U	2 U	8 B	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	12	1 U	0.4 J	110	1 U	1 U	1 U	2 U	8 B	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	17	1 U	0.5 J	85	1 U	1 U	1 U	2 U	5 J	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	43-45	13	1 U	0.6 J	240	1 U	1 U	1 U	2 U	5 U	8	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
GW-18																						
	08-10	5	1 U	0.4 J	150	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	7	1 U	1 U	70	1 U	1 U	1 U	2 U	5 B	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	30	1 U	0.7 J	290	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	17	3	1 U	23	1 U	1 U	1 U	2 U	8 B	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	1 U	1 U	1 U	3 U	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 UJ	2 U	1 U	1 U
	38-40	1 U	1 U	1 U	1 J	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	1 U	1 U	0.5 J	3 U	1 U	1 U	1 U	2 U	5 B	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
GW-19																						
	08-10	5	1 U	0.4 J	2 J	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	15	1 U	1 U	33	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	10	1 U	1 U	3	1 U	1 U	1 U	2 U	6	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 UJ	2 U	1 U	1 U
	28-30	29	50	4	610	1 U	1 U	0.5 J	2 U	13	32	5 U	5 U	0.4 J	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	18	110	20	290	1 U	0.8 J	86	34	12	130	5 U	5 U	2 J	1 U	2	1 U	3	2 U	2 U	1 U	1 U
	38-40	5	23	5	34	1 U	1 U	15	16	10	220	5 U	5 U	0.5 J	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
GW-20																						
	18-20	26	1 U	1	460	1 U	1 U	0.5 J	2 U	10	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	17	40	1	720	1 U	1 U	1 U	2 U	12	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	21	1 U	0.5 J	65	1 U	1 U	1 U	2 U	14 B	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	29	45	3	630	1 U	1 U	1 U	2 U	8 B	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	26	71	5	550	1 U	1 U	1 U	2 U	15	32	5 U	5 U	0.5 J	1 U	3	1 U	1 U	2 U	2 U	1 U	1 U
GW-21																						
	18-20	14	130 J	3	530 J	1 U	1 U	1 U	2 U	11	25	5 U	5 U	5 U	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	24	160	160	970 E	1 U	10	89	440 E	12	38	8	2 J	5 U	1 U	1 U	2	1 U	2 U	2 U	1 U	1 U
	33-35	17	190	120	770	1 U	1 U	1 U	2 U	7	20	4 J	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	8	27	2	310	1 U	1 U	1 U	2 U	14	5 U	3 J	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	12	100	3	650	1 U	1 U	1 U	2 U	14	54	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
ICL (ug/L):		**5**	**700**	**1,000**	**10,000**	**5**	**5**	**70**	**2**	**700**	**154**	**200**	**350**	**5**	**200**	**81**	**7**	**5**	**10**	**3**	**---**	**---**

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 1 of 2

Dover Municipal Landfill Superfund Site

Dover, New Hampshire

Boring	Depth Below Grade (ft)	Benzene	Ethyl-benzene	Toluene	Total Xylenes	PCE	TCE	cis-1,2-DCE	Vinyl Chloride	Acetone	Tetrahydro-furan	2-Butanone	4-Methyl 2-Pentanone	Methylene-Chloride	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Bromo-methane	Chloro-methane	Chloro-form	Dibromo-chloro-methane
GW-22																						
	08-10	**16**	1 U	0.4 J	52	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	**9**	1 U	1 U	1 J	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**10**	1 U	1 U	110	1 U	1 U	1 U	2 U	5 U	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30*	**20**	100	2	690	1 U	1 U	1	2 U	4 J	18	5 U	5 U	0.9 J	1 U	0.7 J	1 U	1	2 U	2 U	1 U	1 U
	33-35	4	11	2	3 J	1 U	1 U	6	**8**	9 B	13	5 U	5 U	0.7 J	1 U	1 J	1 U	1 U	2 U	2 U	1 U	1 U
GW-23																						
	18-20	5	1 U	2	280	1 U	1 U	1 U	2 U	7 B	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**16**	130	2	2100	1 U	1 U	1 U	2 U	8 B	3 J	5 U	5 U	5 U	1 U	0.8 J	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**24**	240	260	980	1 U	1 U	0.7 J	2 U	7	**1900**	5 U	12	2 JB	1 U	4	1 U	4	2 U	2 U	1 U	1 U
	33-35	**16**	130	460	510	1 U	1 U	1	**5**	7	**770**	5 U	5 U	2 JB	1 U	14	1 U	**6**	2 U	2 U	1 U	1 U
GW-24																						
	18-20	**37**	120	120	120	1 U	1 U	1 U	2 U	54	62	86	110	5 U	1 U	0.6 J	1 U	1	2 U	2 U	1 U	1 U
GW-25																						
	18-20	**22**	29	1	330	1 U	1 U	1 U	2 U	13	44	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**18**	1 U	0.8 J	200	1 U	1 U	1 U	2 U	11	89	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**35**	14	4	380	1 U	1 U	1 U	2 U	32	**500**	6	5 U	0.5 J	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**38**	38	3	570	1 U	1 U	0.6 J	2 U	18	**430**	5 U	5 U	5 U	1 U	1	1 U	1 U	2 U	2 U	1 U	1 U
	43-45	**27**	1 U	2	750	1 U	1 U	1	2 U	24	**620**	5 U	5 U	5 U	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	**23**	140	9 B	680	1 U	1 U	4	2 U	18 B	**1600**	5 U	5 U	0.6 JB	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
GW-26																						
	08-10	0.9 J	0.6 J	0.8 J	1 J	1 U	1 U	1 U	2 U	15	5 U	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	18-20	**24**	1 U	0.7 J	110 J	1 U	1 U	1 U	2 U	27	**180 J**	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**21**	28	92	140	1 U	1 U	1 U	**12**	32	**500**	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**15**	1 U	2	360	1 U	1 U	1 U	2 U	28	**390**	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**33**	1 U	2	280	1 U	1 U	1 U	2 U	10	**480**	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**50**	1 U	2	350	1 U	1 U	1 U	2 U	19	**1600 J**	5 UJ	5 UJ	5 U	1 U	1 U	1 U	1 UJ	2 UJ	2 UJ	1 U	1 U
	48-50	**13**	27	4	91	1 U	1 U	0.5 J	2 U	6	**790**	5 U	5 U	5 U	1 U	0.6 J	1 U	1 U	2 U	2 U	1 U	1 U
GW-27																						
	18-20	**27**	400	0.8 J	1700	1 U	1 U	0.4 J	2 U	11	30	5 U	5 U	0.4 J	1 U	3	1 U	1 U	2 U	2 U	1 U	1 U
	23-25	**23**	120	1	830	1 U	1 U	1 U	2 U	18	150	5 U	5 U	0.8 J	1 U	8	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	4	12	2	5	1 U	0.6 J	20	**33**	8	14	5 U	5 U	0.6 J	1 U	4	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	1 U	0.4 J	0.7 J	3 U	1 U	1 U	30	**13**	4 J	5 U	5 U	5 U	5 U	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
GW-28																						
	18-20	**16**	67	2	950	1 U	1 U	1 U	2 U	16	16	3 J	5 U	5 U	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**14**	300	13	1100	1 U	1 U	0.6 J	2 U	21	**1100**	5 U	5 U	5 U	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
GW-29																						
	18-20	**17**	54	2	510	1 U	1 U	1 U	2 U	5	71	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**53**	110	12	590	1 U	1 U	1 U	2 U	8	69	3 J	5 U	0.7 J	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**25**	1 U	2	660	1 U	1 U	1 U	2 U	9	50	2 J	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	43-45	**22**	120	8	830	1 U	1 U	1 U	2 U	10	41	3 J	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	**16**	83	10 B	540	1 U	1 U	1	2 U	19 B	**240**	3 J	5 U	0.8 JB	1 U	0.5 J	1 U	1 U	2 U	2 U	1 U	1 U
	53-55	**16**	94	350	530	1 U	1 U	0.8 J	2 U	130	**710**	28	5 U	0.4 J	1 U	0.7 J	1 U	5	2 U	2 U	1 U	1 U
	58-60	**7**	71	29 B	380	1 U	2	3	2 U	30 B	110	6	170	0.9 JB	1 U	0.5 J	1 U	1	2 U	2 U	1 U	1 U
ICL (ug/L):		**5**	**700**	**1,000**	**10,000**	**5**	**5**	**70**	**2**	**700**	**154**	**200**	**350**	**5**	**200**	**81**	**7**	**5**	**10**	**3**	**---**	**---**

TABLE 1-5
Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill
VOC Set 1 of 2
Dover Municipal Landfill Superfund Site
Dover, New Hampshire

Boring	Depth Below Grade (ft)	Benzene	Ethyl-benzene	Toluene	Total Xylenes	PCE	TCE	cis-1,2-DCE	Vinyl Chloride	Acetone	Tetrahydro-furan	2-Butanone	4-Methyl 2-Pentanone	Methylene-Chloride	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	Bromo-methane	Chloro-methane	Chloro-form	Dibromo-chloro-methane
GW-30																						
	18-20	**23**	1 U	1	260 J	1 U	1 U	1 U	2 U	9	100	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**32**	19	3	250	1 U	1 U	1 U	2 U	33	**530**	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**63**	1 U	3	320	1 U	1 U	1 U	2 U	36	**1400**	5 U	5 U	5 U	1 U	0.6 J	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**40**	77	4	420	1 U	1 U	1 U	2 U	10	**2000**	5 U	5 U	5 U	1 U	0.8 J	1 U	0.5 J	2 U	2 U	1 U	1 U
	43-45	**32**	2	3	84	1 U	1 U	0.4 J	2 U	47	22	13	15	5 U	1 U	1	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	**14**	10	2	40	1 U	1 U	0.5 J	2 U	17	**420**	5 U	5 U	0.5 J	1 U	2	1 U	0.8 J	2 U	2 U	1 U	1 U
GW-31																						
	28-30	**12**	230	1 J	850	1 U	1 U	0.7 J	2 U	13	25	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**12**	22	3	560	1 U	1 U	1 U	2 U	17	**360**	5 U	5 U	5 U	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
GW-32																						
	18-20	**26**	23	2	33	1 U	1 U	1 U	2 U	9	22	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	28-30	**17**	38	4	520	1 U	1 U	1 U	2 U	6	61	5 U	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**50**	24	37	170	1 U	1 U	1 U	2 U	49	**450**	4 J	5 U	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	43-45	**24**	170	10	540	1 U	1 U	0.5 J	2 U	31	**3200**	5 U	5 U	2 J	1 U	2	1 U	1 U	2 U	2 U	1 U	1 U
	53-55	**19**	98	10	350	1 U	1 U	0.4 J	2 U	61	**5500**	5 U	5 U	0.9 J	1 U	1	1 U	1 U	2 U	2 U	1 U	1 U
	63-65	1 U	0.5 J	1 U	1 J	1 U	1 U	1 U	0.5 J	8	25	5 U	4 J	5 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
GW-33																						
	28-30	**49**	62	22 B	120	1 U	1 U	1 U	2 U	27 B	**720**	5 U	5 U	0.6 JB	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U
	33-35	**29**	1 U	10	470	1 U	1 U	1 U	2 U	14	110	5 U	5 U	5 U	1 U	1	1 U	1 U	2 U	2 U	1 U	1 U
	38-40	**37**	190	11 B	960	1 U	1 U	1 U	2 U	24 B	**1800**	5 U	5 U	**8 B**	1 U	3	1 U	1 U	2 U	2 U	1 U	1 U
	43-45	**27**	360	17	1200	1 U	1 U	1 U	2 U	37	**4100**	5 U	5 U	**11 B**	1 U	5	1 U	1 U	2 U	2 U	1 U	1 U
	48-50	3	13	8	25	1 U	1 U	16	**9**	14	**980**	5 U	140	0.9 J	1 U	14	1 U	1 U	2 U	2 U	1 U	1 U
ICL (ug/L):		**5**	**700**	**1,000**	**10,000**	**5**	**5**	**70**	**2**	**700**	**154**	**200**	**350**	**5**	**200**	**81**	**7**	**5**	**10**	**3**	**---**	**---**

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 2 0f 2
Dover Municipal Landfill Superfund Site
Dover, New Hampshire

Boring	Depth Below Grade (ft)	Bromo-form	Carbon Disulfide	Styrene	Chloro-ethane	Chloro-benzene	1,2-Dichloro-propane	1,1,2-Trichloro-ethane	cis-1,3-Dichloro-propene	trans-1,3-Dichloro-propene	1,1,2,2-Tetrachloro-ethane	2-Hexanone	1,2-Dichloro-benzene	1,2,4-Trimethyl-benzene	1,3,5-Trimethyl-benzene	1,4 Dichloro-benzene	4-Isopropyl-toluene	Dichloro-difluoro-methane	Isopropyl-benzene	Naphth-alene	n-Propyl-benzene
GW-01																					
	08-10	1 U	1 U	1 U	2 U	5	1 U	1 U	1 U	1 U	1 U	5 U	0.9 J	1 U	1 U	2	1 UJ	2 U	3	2 B	1
	18-20	1 U	1 U	1 U	2 U	29	1 U	1 U	1 U	1 U	1 U	5 U	1	0.6 J	1 U	6	1 U	2 U	10	2 B	0.9 J
	23-25	1 U	1 U	1 U	2 U	14	1	1 U	1 U	1 U	1 U	5 U	0.9 J	7	9	6	0.8 J	1 J	34	5	3
	28-30	1 U	1	1 U	2 U	7	1 U	1 U	1 U	1 U	1 U	5 U	1 J	1	5	4	0.6 J	0.7 J	11	3 B	2
	33-35	1 U	1 U	1 U	2 U	1 U	1	1 U	1 U	1 U	1 U	5 U	1 U	1 U	0.6 J	1 U	1 U	2 U	10	1 U	1 U
	38-40	1 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
	48-50	1 U	0.8 J	1 U	2 U	0.4 J	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
GW-02																					
	08-10	1 U	0.6 J	1 U	2 U	8	1 U	1 U	1 UJ	1 U	1 U	5 U	1 U	0.4 J	1 UJ	2	1 UJ	2 U	1 J	1 U	1 U
	18-20	1 U	1 U	1 U	2 U	44	1 U	1 U	1 U	1 U	1 U	5 U	1	2	1 U	8	1 U	2 U	3	1 U	0.6 J
	23-25	1 U	1	1 U	2 U	28	1 U	1 U	1 U	1 U	1 U	5 U	0.9 J	0.6 J	1 U	5	1 U	0.8 J	2	0.4 J	1 U
	28-30	1 U	1 U	1 U	2 U	14	1 U	1 U	1 U	1 U	1 U	5 U	0.8 J	69	16	6	1	2 J	41	7	6
	33-35	1 U	0.8 J	1 U	2 U	5	2	1 U	1 U	1 U	1 U	5 U	0.8 J	17	5	3	1	0.8 J	33	2	2
	38-40	1 U	1 U	1 U	2 U	2	2	1 U	1 U	1 U	1 U	5 U	1	12	4	1	0.4 J	2 U	17	0.8 J	2
	48-50	1 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
	58-60	1 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
GW-03																					
	08-10	1 U	0.8 J	1 U	2 U	7	1 U	1 U	1 U	1 U	1 U	5 U	1	1 U	1 U	3	1 U	2 U	1	0.6 J	1 U
	18-20	1 U	1 J	1 U	2 U	12	1 U	1 U	1 U	1 U	1 U	5 U	1	0.7 J	1 U	4	1 U	2 U	2	0.7 J	1 U
	23-25	1 U	2	1 U	2 U	9	1 U	1 U	1 U	1 U	1 U	5 U	1 U	7	1 U	2	1 U	2 U	2	3	1 U
	28-30	1 U	1 U	1 U	2 U	9	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	1	1 U	4	1 U	1 J	34	3	0.5 J
	33-35	1 U	1	1 U	2 U	12	4	1 U	1 U	1 U	1 U	5 U	0.8 J	34	9	4	1	1 J	62	5	3
	38-40	1 U	0.9 J	1 U	2 U	4	6	1 U	1 U	1 U	1 U	5 U	0.7 J	18	5	3	3	2 U	70	2	2
	48-50	1 U	0.9 J	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1	1 U	1 U
	58-60	1 U	0.9 J	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
GW-04																					
	08-10	1 U	1	1 U	2 U	25	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	76	12	4	0.6 J	2 U	9	3	7
	18-20	1 U	1	1 U	2 U	17	1 U	1 U	1 U	1 U	1 U	5 U	1 U	17	5	4	1 U	2 U	6	2	2
	23-25	1 U	1	1 U	2 U	31	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	9	4	6	1 U	2 U	10	1	2
	28-30	1 U	1 U	1 U	2 U	18	1 U	1 U	1 U	1 U	1 U	5 U	1	1 U	1 U	7	1 U	0.8 J	26	1	2
	33-35	1 U	1 U	1 U	2 U	2	4	1 U	1 U	1 U	1 U	5 U	1 U	3	1	1	1	1 J	62	0.2 JB	1 U
	38-40	1 U	1 U	1 U	2 U	7	3	1 U	1 U	1 U	1 U	5 U	0.8 J	28	7	5	2	2 J	48	1 B	3
	48-50	1 U	1 U	1 U	2 U	0.5 J	1 U	1 U	1 U	1 U	1 U	5 U	1 U	15	5	1 U	0.9 J	0.6 J	11	1 U	2
	58-60	1 U	1	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
ICL (ug/L):		**4**	**7**	**100**	**14,000**	**---**	**5**	**5**	**0.2**	**0.2**	**0.17**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**

Concentrations reported in ug/L (ppb).

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 2 0f 2
Dover Municipal Landfill Superfund Site
Dover, New Hampshire

Boring	Depth Below Grade (ft)	Bromo-form	Carbon Disulfide	Styrene	Chloro-ethane	Chloro-benzene	1,2-Dichloro-propane	1,1,2-Trichloro-ethane	cis-1,3-Dichloro-propene	trans-1,3-Dichloro-propene	1,1,2,2-Tetrachloro-ethane	2-Hexanone	1,2-Dichloro-benzene	1,2,4-Trimethyl-benzene	1,3,5-Trimethyl-benzene	1,4 Dichloro-benzene	4-Isopropyl-toluene	Dichloro-difluoro-methane	Isopropyl-benzene	Naphth-alene	n-Propyl-benzene
GW-05																					
	08-10	1 U	1 U	1 U	2 U	5	1 U	1 U	1 U	1 U	1 U	5 U	0.7 J	38	15	3	1 U	2 U	10	9	7
	18-20	1 U	1 U	1 U	2 U	16	1 U	1 U	1 U	1 U	1 U	5 U	1	39	10	7	1 U	2 U	9	11	7
	23-25	1 U	1 U	1 U	2 U	16	1 U	1 U	1 U	1 U	1 U	5 U	1	22	7	7	1 U	2 U	9	6	4
	28-30	1 U	0.6 J	1 U	2 U	9	2	1 U	1 U	1 U	1 U	5 U	1	32	10	6	0.7 J	2 U	29	3	5
	33-35	1 U	0.8 J	1 U	2 U	7	3	1 U	1 U	1 U	1 U	5 U	0.4 J	21	6	2	2	2 U	55	0.8 J	2
	38-40	1 U	1 U	1 U	2 U	4	**6**	1 U	1 U	1 U	1 U	5 U	1 U	12	3	1	3	2 U	94	0.4 J	1
	48-50	1 U	2	1 U	2 U	2	2	1 U	1 U	1 U	1 U	5 U	0.4 J	1	3	0.9 J	1 U	2 U	10	0.7 J	2
	58-60	1 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
GW-06																					
	08-10	1 U	2	1 U	2 U	5	1 U	1 U	1 U	1 U	1 U	5 U	2	1	7	2	0.6 J	2 U	4	3	1 U
	18-20	1 U	1 U	1 U	2 U	6	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	35	11	4	4	2 U	14	3	5
	23-25	1 U	0.7 J	1 U	2 U	23	1 U	1 U	1 U	1 U	1 U	5 U	1	84	27	13	2	2 U	12	13	13
	28-30	1 U	3	1 U	2 U	26	1 U	1 U	1 U	1 U	1 U	5 U	3	80	26	10	0.7 J	2 U	14	12	16
	33-35	1 U	2	1 U	2 U	10	1 U	1 U	1 U	1 U	1 U	5 U	2	30	10	7	2	2 U	11	4	5
	38-40	1 U	0.7 J	1 U	2 U	8	1 U	1 U	1 U	1 U	1 U	5 U	0.9 J	1 U	1 U	6	1 U	2 U	5	1	0.5 J
	48-50	1 U	0.8 J	1 U	2 U	4	1 U	1 U	1 U	1 U	1 U	5 U	0.6 J	0.5 J	1 U	2	1 U	0.6 J	5	0.8 J	0.5 J
	58-60	1 U	1 U	1 U	2 U	0.8 J	4	1 U	1 U	1 U	1 U	5 U	0.4 J	2	2	1 U	1 U	2 U	1	1 U	1 U
GW-07																					
	08-10	1 U	1	1 U	2 U	11	1 U	1 U	1 U	1 U	1 U	5 U	2	17	2	3	0.5 J	2 U	5	4	2
	18-20	1 U	1 J	1 U	2 U	9	1 U	1 U	1 U	1 U	1 U	5 U	2	0.5 J	2	4	1 U	2 U	2	1 UJ	1 U
	23-25	1 U	1	1 U	2 U	7	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	1 U	1 U	3	1 U	0.4 J	4	1 U	1 U
	28-30	1 U	0.9 J	1 U	2 U	11	1 U	1 U	1 U	1 U	1 U	5 U	0.6 J	45	15	7	1 U	2 U	9	7	8
	33-35	1 U	1	1 U	2 U	10	1 U	1 U	1 U	1 U	1 U	5 U	1	30	11	7	0.9 J	0.7 J	11	3	6
	38-40	1 U	1	1 U	2 U	14	1 U	1 U	1 U	1 U	1 U	5 U	2	1 U	1 U	6	1 U	1 J	4	1 U	0.4 J
	48-50	1 U	1 U	1 U	2 U	12	1 U	1 U	1 U	1 U	1 U	5 U	2	5	1	6	1 U	2	9	2	2
	58-60	1 U	1	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	0.6 J	1 U	1 U	1 U	0.7 J	2	1 U	1 U
GW-08																					
	18-20	1 U	0.8 J	0.7 J	2 U	6	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	13 J	1 U	2	1 UJ	2 U	2	34	1 U
	23-25	1 U	1 U	1 U	2 U	31	1 U	1 U	1 U	1 U	1 U	5 U	0.7 J	1	1 U	8	1	2 U	1	4	1 U
	28-30	1 U	0.7 J	1 U	2 U	19	1 U	1 U	1 U	1 U	1 U	5 U	0.8 J	4	4	9	0.5 J	2 U	54	3	4
	33-35	1 U	2	1 U	2 U	15	1 U	1 U	1 U	1 U	1 U	5 U	0.8 J	61	14	5	0.6 J	2 U	28	7	6
	38-40	1 U	0.9 J	1 U	2 U	6 J	1 U	1 U	1 U	1 U	1 U	5 U	0.9 J	16 J	5 J	3 J	0.5 J	2 U	8 J	2 J	2 J
	48-50	1 U	3	1 U	2 U	2	1 U	1 U	1 U	1 U	1 U	5 U	1 U	10	3	0.6 J	1 U	2 U	5	1	0.9 J
	58-60	1 U	2	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	0.5 J	1 U	1 U	1 U	2 U	1 U	0.6 J	1 U
GW-09																					
	08-10	1 U	1	1 U	2 U	59	1 U	1 U	1 U	1 U	1 U	5 U	1	76	24	18	2	2 U	20	28	18
	18-20	1 U	2	1 U	2 U	16	1 U	1 U	1 U	1 U	1 U	5 U	1 U	24	7	9	2	2 U	5	11	4
	23-25	1 U	3	1 U	2 U	11	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	28	5	4	1 U	2 U	5	7	3
	28-30	1 U	6	1 U	2 U	17	1 U	1 U	1 U	1 U	1 U	5 U	0.8 J	16	4	6	0.8 J	2 U	10	7	5
	33-35	1 U	1	1 U	2 U	12	1 U	1 U	1 U	1 U	1 U	5 U	0.6 J	18	7	5	1 U	2 U	13	3	3
	38-40	1 U	2	1 U	2 U	13	1 U	1 U	1 U	1 U	1 U	5 U	1	1	1	7	1 U	2 U	12	2	2
	48-50	1 U	1	1 U	2 U	4	1 U	1 U	1 U	1 U	1 U	5 U	0.9 J	27	8	2	2	2 U	25	1	4
	58-60	1 U	3	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	2	0.6 J	1 U	1 U	2 U	4	0.4 J	1 U
ICL (ug/L):		**4**	**7**	**100**	**14,000**	**---**	**5**	**5**	**0.2**	**0.2**	**0.17**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**

Concentrations reported in ug/L (ppb).

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 2 0f 2
Dover Municipal Landfill Superfund Site
Dover, New Hampshire

Boring	Depth Below Grade (ft)	Bromo-form	Carbon Disulfide	Styrene	Chloro-ethane	Chloro-benzene	1,2-Dichloro-propane	1,1,2-Trichloro-ethane	cis-1,3-Dichloro-propene	trans-1,3-Dichloro-propene	1,1,2,2-Tetrachloro-ethane	2-Hexanone	1,2-Dichloro-benzene	1,2,4-Trimethyl-benzene	1,3,5-Trimethyl-benzene	1,4 Dichloro-benzene	4-Isopropyl-toluene	Dichloro-difluoro-methane	Isopropyl-benzene	Naphth-alene	n-Propyl-benzene
GW-10																					
	18-20	1 U	0.8 J	1 U	2 U	2	1 U	1 U	1 U	1 U	1 U	5 U	3	53	12	2	2	2 U	9	3	5
	23-25	1 U	0.6 J	1 U	2 U	14	1 U	1 U	1 U	1 U	1 U	5 U	0.9 J	11	6	7	1 U	2 U	4	1	1
	28-30	1 U	3	1 U	2 U	10	1 U	1 U	1 U	1 U	1 U	5 U	1	30	9	3	0.4 J	2 U	4	5	3
	33-35	1 U	4	1 U	2 U	19	1 U	1 U	1 U	1 U	1 U	5 U	1	46	14	6	1 U	2 U	8	14	7
	38-40	1 U	3	1 U	2 U	10	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	4	4	3	1 U	2 U	2	3	0.6 J
	48-50	1 U	4	1 U	2 U	1	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	1	0.8 J	0.6 J	0.6 J	2 U	2	0.7 J	1 U
GW-11																					
	08-10	1 U	1 U	1 U	2 U	5	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	34	3	2	1	2 U	4	8	4
	18-20	1 U	1 U	1 U	2 U	36	1 U	1 U	1 U	1 U	1 U	5 U	1 J	1 U	1 U	6	1	2 U	8	1	2
	23-25	1 U	1 U	1 U	2 U	32	1 U	1 U	1 U	1 U	1 U	5 U	1	58	18 J	8	1 U	2 U	26 J	3	8
	28-30	1 U	2	1 U	2 U	16	1 U	1 U	1 U	1 U	1 U	5 U	1 J	6	11	7	1 U	2 U	19	9	4
	33-35	1 U	1 U	1 U	2 U	0.4 J	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
	38-40	1 U	1 U	1 U	2 U	3	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	1 U	1 U	1 U	1 U	2 U	1	1 U	1 U
	48-50	1 UJ	2 J	1 UJ	2 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	5 UJ	1 UJ	1 J	1 UJ	1 UJ	1 UJ	2 UJ	1 UJ	1 UJ	1 UJ
	58-60	1 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
GW-12																					
	08-10	1 U	1 U	1 U	2 U	11	1 U	1 U	1 U	1 U	1 U	5 U	1 U	2	1 U	2	1 U	2 U	2	0.5 J	1
	18-20	1 U	1 U	1 U	2 U	16	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	64	21	8	2	2 U	30	5	9
	23-25	1 U	2	1 U	2 U	32	1 U	1 U	1 U	1 U	1 U	5 U	1 U	17	2	5	1	2 U	10	5	3
	28-30	1 U	2	1 U	2 U	35	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	7	1 J	6	1 UJ	2 U	5 J	3	2
	33-35	1 U	1 U	1 U	2 U	22	1 U	1 U	1 U	1 U	1 U	5 U	0.7 J	1 U	1 U	6	1 U	2 U	5	1 U	0.6 J
	38-40	1 U	1 U	1 U	2 U	35	1 U	1 U	1 U	1 U	1 U	5 U	1 J	49	13	9	1 U	1 J	14	7	4
	48-50	1 U	1 U	1 U	2 U	6	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	9	4	1	0.6 J	2 U	9	0.7 J	3
GW-13																					
	18-20	1 U	1	1 U	2 U	25	1 U	1 U	1 U	1 U	1 U	5 U	0.8 J	55	16	8	0.5 J	2 U	6	42	7
	28-30	1 U	2	1 U	2 U	24	1 U	1 U	1 U	1 U	1 U	5 U	1	69	19	7	0.7 J	2 U	16	16	10
	33-35	1 U	3	1 U	2 U	31	1 U	1 U	1 U	1 U	1 U	5 U	2	55	16	7	0.7 J	2 U	12	15	11
	38-40	1 U	2	1 U	2 U	15	1 U	1 U	1 U	1 U	1 U	5 U	1 J	39 J	9 J	5	1 U	2 U	12	4	6
	43-45	1 U	2	1 U	2 U	5	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	30	5	3	0.5 J	2 U	6	2	3
	58-60	2 U	5	2 U	4 U	6	2 U	2 U	2 U	2 U	2 U	10 U	1 J	33	10	2	1 J	4 U	18	3	5
GW-14																					
	18-20	1 U	2	1 U	2 U	9	1 U	1 U	1 U	1 U	1 U	5 U	2	24	8	3	1	2 U	8	12	3
	23-25	1 U	4	1 U	2 U	15	1 U	1 U	1 U	1 U	1 U	5 U	0.8 J	78	25	6	0.7 J	2 U	16	16	10
	28-30	1 U	1	1 U	2 U	28	1 U	1 U	1 U	1 U	1 U	5 U	1	46	15	7	1 U	2 U	11	9	9
	33-35	1 U	1 J	1 U	2 U	32	1 U	1 U	1 U	1 U	1 U	5 U	4	71	25	7	0.8 J	2 U	17	13	17
	38-40	1 U	1 J	1 U	2 U	61	1 U	1 U	1 U	1 U	1 U	5 U	4	49	14	12	1 U	2 J	3	10	1 U
	48-50	1 U	0.9 J	1 U	2 U	14	1 U	1 U	1 U	1 U	1 U	5 U	3	7	4	2	1 U	2 J	9	0.9 J	0.8 J
ICL (ug/L):		**4**	**7**	**100**	**14,000**	**---**	**5**	**5**	**0.2**	**0.2**	**0.17**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**

Concentrations reported in ug/L (ppb).

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 2 0f 2

Dover Municipal Landfill Superfund Site

Dover, New Hampshire

Boring	Depth Below Grade (ft)	Bromo-form	Carbon Disulfide	Styrene	Chloro-ethane	Chloro-benzene	1,2-Dichloro-propane	1,1,2-Trichloro-ethane	cis-1,3-Dichloro-propene	trans-1,3-Dichloro-propene	1,1,2,2-Tetrachloro-ethane	2-Hexanone	1,2-Dichloro-benzene	1,2,4-Trimethyl-benzene	1,3,5-Trimethyl-benzene	1,4 Dichloro-benzene	4-Isopropyl-toluene	Dichloro-difluoro-methane	Isopropyl-benzene	Naphth-alene	n-Propyl-benzene
GW-15																					
	08-10	1 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
	18-20	1 U	0.9 J	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	0.5 J	1 U	1 U
	23-25	1 U	1 U	1 U	2 U	36	1 U	1 U	1 U	1 U	1 U	5 U	0.7 J	22	5	7	1	2 U	15	5 B	4
	28-30	1 U	3	1 U	2 U	37	1 U	1 U	1 U	1 U	1 U	5 U	1	20	3	6	0.5 J	2 U	10	12	3
	33-35	1 U	2	1 U	2 U	10	1 U	1 U	1 U	1 U	1 U	5 U	0.9 J	5	10	4	1 U	2 U	6	7	5
	38-40	1 U	3	1 U	2 U	6	1 U	1 U	1 U	1 U	1 U	5 U	0.6 J	0.8 J	2	2	1 J	2 U	2	2 B	0.7 J
	48-50	1 U	0.9 J	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
	58-60	1 U	0.6 J	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
GW-16																					
	18-20	1 U	0.7 JB	1 U	2 U	7	1 U	1 U	1 U	1 U	1 U	5 U	0.8 J	38	10	7	1 U	2 U	7	19	7
	23-25	1 U	2 B	1 U	2 U	15	1 U	1 U	1 U	1 U	1 U	5 U	0.8 J	6	1	6	1 U	2 U	8	9	3
	28-30	1 UJ	1 U	1 U	2 U	10	1 U	1 UJ	1 UJ	1 UJ	1 UJ	5 UJ	0.7 J	26 J	4 J	4	1 J	2 UJ	8 J	3 J	5 J
	33-35	1 U	3	1 U	2 U	10	1 U	1 U	1 U	1 U	1 U	5 U	0.7 J	3	1	5	1 U	2 U	8	2	4
	38-40	1 U	1 U	1 U	2 U	9	1 U	1 U	1 U	1 U	1 U	5 U	0.8 J	2	1 U	4	1	2 U	7	0.8 JB	3
	48-50	1 U	0.8 J	1 U	2 U	3	1 U	1 U	1 U	1 U	1 U	5 U	0.7 J	52	17	1	3	2 U	26	1 B	9
	58-60	1 U	0.6 J	1 U	2 U	2	1 U	1 U	1 U	1 U	1 U	1 J	2	39	13	0.8 J	2	2 U	23	1	6
	68-70	1 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 B	1 U
GW-17																					
	18-20	1 U	1 U	1 U	2 U	67	1 U	1 U	1 U	1 U	1 U	5 U	5	150	50	10	2	2 U	27	9	30
	28-30	1 U	1 B	1 U	2 U	72	1 U	1 U	1 U	1 U	1 U	5 U	3	24	8	14	0.4 J	2 U	9	14	3
	33-35	1 U	2 B	1 U	2 U	49	1 U	1 U	1 U	1 U	1 U	5 U	2	24	9	9	1 U	2 U	4	5	1
	38-40	1 U	2	1 U	2 U	37	1 U	1 U	1 U	1 U	1 U	5 U	3	37	14	8	0.8 J	2 U	7	5	3
	43-45	1 U	2	1 U	2 U	66	1 U	1 U	1 U	1 U	1 U	5 U	4	42	14	8	2	2 U	8	3	2
GW-18																					
	08-10	1 U	1 U	1 U	2 U	21	1 U	1 U	1 U	1 U	1 U	5 U	0.8 J	100	38	6	3	2 U	17	10 B	12
	18-20	1 U	0.6 J	1 U	2 U	27	1 U	1 U	1 U	1 U	1 U	5 U	0.7 J	67	22	6	1	2 U	14	18	7
	23-25	1 U	1 J	1 U	2 U	30	1 U	1 U	1 U	1 U	1 U	5 U	1	89	22	8	1	2 U	16	4 B	8
	28-30	1 U	3	1 U	2 U	10	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	10	5	4	1 U	2 U	9	7	2
	33-35	1 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U	1 UJ	1 UJ	5 U	1 UJ	0.5 J	1 U	1 U	1 U	2 U	1 U	1 JB	1 U
	38-40	1 U	1	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	0.8 J	1 U	1 U	1 U	2 U	1 U	0.7 JB	1 U
	48-50	1 U	2	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
GW-19																					
	08-10	1 U	1 U	1 U	2 U	18	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	0.6 J	1 U	7	1 U	2 U	10	4	2
	18-20	1 U	1 U	1 U	2 U	41	1 U	1 U	1 U	1 U	1 U	5 U	1	15	2	7	0.4 J	2 U	7	8 B	3
	23-25	1 U	1 U	1 U	2 U	25	1 U	1 U	1 U	1 U	1 U	5 UJ	0.8 J	0.7 J	1 U	7	1 U	2 U	4	0.5 J	2
	28-30	1 U	2 B	1 U	2 U	4	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	81	30	3	2	2 U	18	4	11
	33-35	1 U	0.7 JB	1 U	2 U	0.8 J	1 U	1 U	1 U	1 U	1 U	5 U	1 U	45	15	0.5 J	1	2 U	18	0.4 J	8
	38-40	1 U	1	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	2	0.9 J	1 U	1 U	2 U	7	1 U	1 U
ICL (ug/L):		4	7	100	14,000	---	5	5	0.2	0.2	0.17	---	---	---	---	---	---	---	---	---	---

Concentrations reported in ug/L (ppb).

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 2 0f 2

Dover Municipal Landfill Superfund Site

Dover, New Hampshire

Boring	Depth Below Grade (ft)	Bromo-form	Carbon Disulfide	Styrene	Chloro-ethane	Chloro-benzene	1,2-Dichloro-propane	1,1,2-Trichloro-ethane	cis-1,3-Dichloro-propene	trans-1,3-Dichloro-propene	1,1,2,2-Tetrachloro-ethane	2-Hexanone	1,2-Dichloro-benzene	1,2,4-Trimethyl-benzene	1,3,5-Trimethyl-benzene	1,4 Dichloro-benzene	4-Isopropyl-toluene	Dichloro-difluoro-methane	Isopropyl-benzene	Naphth-alene	n-Propyl-benzene
GW-20																					
	18-20	1 U	2	1 U	2 U	21	1 U	1 U	1 U	1 U	1 U	5 U	3	87	39	4	3	2 U	13	5	16
	23-25	1 U	3	1 U	2 U	20	1 U	1 U	1 U	1 U	1 U	5 U	2	330	120	9	3	2 U	52	11	86
	28-30	1 U	3 B	1 U	2 U	70	1 U	1 U	1 U	1 U	1 U	5 U	6	40	14	10	0.8 J	2 U	9	12	3
	33-35	1 U	1 B	1 U	2 U	84	1 U	1 U	1 U	1 U	1 U	5 U	4	48	17	9	2	2 U	12	4	6
	38-40	1 U	2	1 U	2 U	140	1 U	1 U	1 U	1 U	1 U	5 U	10	42	15	12	2	2 U	19	4	5
GW-21																					
	18-20	1 U	2	1 U	2 U	6	1 U	1 U	1 U	1 U	1 U	5 U	2	40	12	4	0.7 J	2 U	16	6 J	5
	28-30	1 U	1	1 U	2 U	17	1 U	1 U	1 U	1 U	1 U	5 U	2	56	20	4	3	2 U	22	1 U	8
	33-35	1 U	4	1 U	2 U	23	1 U	1 U	1 U	1 U	1 U	5 U	2	46	15	2	4	2 U	17	3	6
	38-40	1 U	6	1 U	2 U	60	1 U	1 U	1 U	1 U	1 U	5 U	6	58	21	15	1	2 U	12	29	9
	48-50	1 U	5	1 U	2 U	23	1 U	1 U	1 U	1 U	1 U	5 U	3	67	26	7	2	2 U	16	18	11
GW-22																					
	08-10	1 U	1 U	1 U	2 U	22	1 U	1 U	1 U	1 U	1 U	5 U	1 J	14	3	3	0.6 J	2 U	14	5	3
	18-20	1 U	1 U	1 U	2 U	4	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	1 U	1 U	2	1 U	2 U	1	1	1 U
	23-25	1 U	1 U	1 U	2 U	12	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	28	16	4	2	2 U	7	2 B	5
	28-30*	1 U	0.6 J	1 U	2 U	1	1 U	1 U	1 U	1 U	1 U	5 U	1 U	87	31	1	2	2 U	22	0.7 JB	16
	33-35	1 U	0.6 J	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	2	2	1 U	1 U	2 U	2	0.4 J	0.5 J
GW-23																					
	18-20	1 U	3 B	1 U	2 U	71	1 U	1 U	1 U	1 U	1 U	5 U	4	31	10	10	0.5 J	2 U	6	20	6
	23-25	1 U	1 B	1 U	2 U	9	1 U	1 U	1 U	1 U	1 U	5 U	1 J	140	49	6	2	2 U	23	6	26
	28-30	1 U	1 U	1 U	2 U	1	1 U	1 U	1 U	1 U	1 U	4 J	1 U	37	12	0.9 J	4	2 U	56	0.8 J	5
	33-35	1 U	1 U	1 U	2 U	0.6 J	1 U	1 U	1 U	1 U	1 U	4 J	0.6 J	21	7	1 U	3	2 U	40	0.9 J	3
GW-24																					
	18-20	1 U	1 U	1 U	2 U	3	1 U	1 U	1 U	1 U	1 U	22	0.7 J	13	4	7	0.9 J	2 U	19	1	2
GW-25																					
	18-20	1 U	1 U	1 U	2 U	3	1 U	1 U	1 U	1 U	1 U	5 U	2	25	8	3	1 U	2 U	6	2	4
	28-30	1 U	0.7 J	1 U	2 U	13	1 U	1 U	1 U	1 U	1 U	5 U	5	18	4	4	0.8 J	2 U	13	8	3
	33-35	1 U	3	1 U	2 U	9	1 U	1 U	1 U	1 U	1 U	5 U	2	21	7	3	0.5 J	2 U	21	8	3
	38-40	1 U	2	1 U	2 U	5	1 U	1 U	1 U	1 U	1 U	5 U	2	48	18	2	2	2 U	11	6	3
	43-45	1 U	4	1 U	2 U	4	1 U	1 U	1 U	1 U	1 U	5 U	2	66	23	2	0.7 J	2 U	9	5	3
	48-50	1 U	0.7 J	1 U	2 U	3	1 U	1 U	1 U	1 U	1 U	5 U	2	38	13	1	3	2 U	29	2	3
GW-26																					
	08-10	1 U	0.7 J	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	3	1 U	1 U	1 U	2 U	0.8 J	3	0.7 J
	18-20	1 U	1 U	1 U	2 UJ	11	1 U	1 U	1 U	1 U	1 U	5 U	3	38 J	2	3	1 J	2 U	18	28	7
	23-25	1 U	2	1 U	2 U	5	1 U	1 U	1 U	1 U	1 U	5 U	2	26	3	1	1	2 U	19	12	4
	28-30	1 U	0.8 J	1 U	2 U	10	1 U	1 U	1 U	1 U	1 U	5 U	2	30	10	3	2	2 U	14	3	2
	33-35	1 U	0.7 J	1 U	2 U	14	1 U	1 U	1 U	1 U	1 U	5 U	4	24	7	3	0.4 J	2 U	15	3	4
	38-40	1 UJ	2	1 U	2 U	25	1 U	1 U	1 U	1 UJ	1 U	5 UJ	11	20	6	5	2	2 U	31 J	1 UJ	3
	48-50	1 U	1	1 U	2 U	3	1 U	1 U	1 U	1 U	1 U	5 U	2	4	1	0.8 J	1	2 U	16	1 U	0.6 J
ICL (ug/L):		**4**	**7**	**100**	**14,000**	**---**	**5**	**5**	**0.2**	**0.2**	**0.17**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**

Concentrations reported in ug/L (ppb).

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 2 0f 2
Dover Municipal Landfill Superfund Site
Dover, New Hampshire

Boring	Depth Below Grade (ft)	Bromo-form	Carbon Disulfide	Styrene	Chloro-ethane	Chloro-benzene	1,2-Dichloro-propane	1,1,2-Trichloro-ethane	cis-1,3-Dichloro-propene	trans-1,3-Dichloro-propene	1,1,2,2-Tetrachloro-ethane	2-Hexanone	1,2-Dichloro-benzene	1,2,4-Trimethyl-benzene	1,3,5-Trimethyl-benzene	1,4 Dichloro-benzene	4-Isopropyl-toluene	Dichloro-difluoro-methane	Isopropyl-benzene	Naphth-alene	n-Propyl-benzene
GW-27																					
	18-20	1 U	0.8 JB	1 U	7	5	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	240	85	4	9	2 U	31	20	36
	23-25	1 U	2 B	1 U	18	2	1 U	1 U	1 U	1 U	1 U	5 U	0.4 J	82	30	3	3	2 U	18	4	13
	28-30	1 U	0.8 J	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	5	2	1 U	1 U	2 U	6	1 U	1
	33-35	1 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
GW-28																					
	18-20	1 U	1 U	1 U	15	33	1 U	1 U	1 U	1 U	1 U	5 U	2	61	22	5	0.8 J	2 U	13	4	10
	38-40	1 U	2	1 U	4	0.8 J	1 U	1 U	1 U	1 U	1 U	5 U	1 U	20	7	0.5 J	1	2 U	33	0.7 J	2
GW-29																					
	18-20	1 U	1 U	1 U	2 U	5	1 U	1 U	1 U	1 U	1 U	5 U	3	19	7	2	0.8 J	2 U	7	6	3
	28-30	1 U	1 U	1 U	2 U	5	1 U	1 U	1 U	1 U	1 U	5 U	0.7 J	46	14	5	2	2 U	21	11	8
	38-40	1 U	4	1 U	2 U	8	1 U	1 U	1 U	1 U	1 U	5 U	0.8 J	68	21	6	3	2 U	13	14	9
	43-45	1 U	6	1 U	2 U	6	1 U	1 U	1 U	1 U	1 U	5 U	1	110	34	4	5	2 U	17	5	18
	48-50	1 U	2	1 U	2 U	4	1 U	1 U	1 U	1 U	1 U	50	2	42	14	2	2	2 U	11	8	6
	53-55	1 U	1 J	1 U	2 U	4	1 U	1 U	1 U	1 U	1 U	23	2	35	11	2	2	2 U	11	5	5
	58-60	1 U	7	1 U	2 U	2	1 U	1 U	1 U	1 U	1 U	5 U	1	46	16	0.9 J	2	2 U	6	9	8
GW-30																					
	18-20	1 U	1 U	1 UJ	2 U	25	1 U	1 U	1 U	1 U	1 U	5 U	4 J	66 J	16 J	6	2 J	2 U	20 J	22	12 J
	28-30	1 U	3	1 U	2 U	10	1 U	1 U	1 U	1 U	1 U	5 U	2	18	6	2	0.6 J	2 U	11	10	3
	33-35	1 U	2	1 U	2 U	26	1 U	1 U	1 U	1 U	1 U	5 U	5	21	8	4	0.5 J	2 U	21	6	3
	38-40	1 U	0.8 J	1 U	2 U	23	1 U	1 U	1 U	1 U	1 U	5 U	6	19	6	4	3	2 U	26	1 U	3
	43-45	1 U	3	1 U	2 U	8	1 U	1 U	1 U	1 U	1 U	5 U	13	0.5 J	3	3	2	2 U	9	2	1 U
	48-50	1 U	3	1 U	2 U	2	1 U	1 U	1 U	1 U	1 U	5 U	2	2	0.9 J	0.5 J	0.9 J	2 U	6	0.4 J	1 U
GW-31																					
	28-30	1 U	0.8 J	1 U	2 U	7	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	94	29	4	3	2 U	18	4	14
	33-35	1 U	2	1 U	2 U	9	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	40	13	6	2	2 U	13	4	4
GW-32																					
	18-20	1 U	1 U	1 U	2 U	0.8 J	1 U	1 U	1 U	1 U	1 U	5 U	0.9 J	4	3	1 U	0.5 J	2 U	7	1	1
	28-30	1 U	1 U	1 U	2 U	24	1 U	1 U	1 U	1 U	1 U	5 U	5	33	10	3	0.7 J	2 U	9	8	4
	38-40	1 U	3	1 U	2 U	32	1 U	1 U	1 U	1 U	1 U	5 U	3	13	4	3	0.5 J	2 U	12	7	2
	43-45	1 U	1	1 U	33	10	1 U	1 U	1 U	1 U	1 U	5 U	3	22	6	2	4	2 U	30	1	2
	53-55	1 U	4	1 U	2 U	4	1 U	1 U	1 U	1 U	1 U	5 U	1	10	3	1	1	2 U	16	3	1
	63-65	1 U	2	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
GW-33																					
	28-30	1 U	1	0.8 J	2 U	33	1 U	1 U	1 U	1 U	1 U	5 U	5	12	4	4	1	2 U	12	1	2
	33-35	1 U	3	0.4 J	2 U	4	1 U	1 U	1 U	1 U	1 U	5 U	0.9 J	26	8	1 J	0.5 J	2 U	6	4	3
	38-40	1 U	2	2	30	5	1 U	1 U	1 U	1 U	1 U	5 U	2	37	11	1 J	2	2 U	22	3	3
	43-45	1 U	5	1 U	110	3	1 U	1 U	1 U	1 U	1 U	5 U	0.5 J	24	7	0.6 J	2	2 U	23	1 J	3
	48-50	1 U	0.9 J	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	5 U	1 U	0.8 J	1 U	1 U	1 U	2 U	2	1 U	1 U
ICL (ug/L):		**4**	**7**	**100**	**14,000**	**---**	**5**	**5**	**0.2**	**0.2**	**0.17**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**

Concentrations reported in ug/L (ppb).

TABLE 1-5

Summary of Discrete Ground Water Quality Data - VOCs, Interior of the Landfill

VOC Set 2 0f 2

Dover Municipal Landfill Superfund Site

Dover, New Hampshire

Boring	Depth Below Grade (ft)	Bromo-form	Carbon Disulfide	Styrene	Chloro-ethane	Chloro-benzene	1,2-Dichloro-propane	1,1,2-Trichloro-ethane	cis-1,3-Dichloro-propene	trans-1,3-Dichloro-propene	1,1,2,2-Tetrachloro-ethane	2-Hexanone	1,2-Dichloro-benzene	1,2,4-Trimethyl-benzene	1,3,5-Trimethyl-benzene	1,4 Dichloro-benzene	4-Isopropyl-toluene	Dichloro-difluoro-methane	Isopropyl-benzene	Naphth-alene	n-Propyl-benzene
ICL (ug/L):		4	7	100	14,000	---	5	5	0.2	0.2	0.17	---	---	---	---	---	---	---	---	---	---

1. µg/L = micrograms per liter or parts per billion (ppb).
2. PCE = tetrachloroethene; TCE = trichloroethene; DCE = dichloroethene; TCA = trichloroethane; DCE = dichloroethane.
3. Total xylenes are a sum of o-xylene, m-xylene, and p-xylene.
4. U= Compound was analyzed for but not detected above to laboratory Practical Quantitation Limit (PQL).
5. J= Estimated value. The analyte was detected in the sample at a concentration less than the laboratory Practical Quantitation Limit (PQL), but above the Method Detection Limit (MDL).
6. B= Indicated the analyte was detected in the laboratory method blank analyzed concurrently with the sample.
7. E = Estimated value. The analyte was detected above the upper limit of the calibration range.
8. * = Sample labeled as GW-22-2530 in the field (and COCs and laboratory data); sample was collected at a depth of 28 to 30 ft below grade.
9. ICL= Interim Cleanup Level.
10. ft = feet.
11. Values highlighted in blue exceed ICLs.

Concentrations reported in ug/L (ppb).


Northwest Landfill Pre-Design Investigation Results
Maximum Benzene Concentration
13'-18' = 120 ug/L
22'-26' = 49 ug/L
GW-01
GW-02
GW-03
GW-04
GW-05
GW-06
GW-07
GW-08
GW-09
GW-10
GW-11
GW-12
GW-13
GW-14
GW-15
GW-16
GW-17
GW-18
GW-19
GW-20
GW-21
GW-22
GW-23
GW-24
GW-25
GW-26
GW-27
GW-28
GW-29
GW-30
GW-31
GW-32
GW-33
NORTH
LEGEND:
GW-29 AS PDI Groundwater Sampling Location
Benzene Concentration (ug/L)
Depth (ft) below ground surface
Benzene ICL (5 ug/L)
XDD
Strategic. Environmental. Solutions.
Scale: 1"= 90'
Date: August 23, 2007
Project No.: 84411
Client: Dover PRP Group
Drawn By: KJW
Checked By: DK
Proj. Mgmt. Approval: MM
Title: Air Sparge Trench PDI – Benzene Results
Drawing No.: FIGURE 1-9A
Rev: 2

Northwest Landfill Pre-Design Investigation Results
Maximum Vinyl Chloride Concentration
13'–18' = 22,493 ug/L
22'–26' = 1,760 ug/L
GW–01
GW–02
GW–03
GW–04
GW–05
GW–06
GW–07
GW–08
GW–09
GW–10
GW–11
GW–12
GW–13
GW–14
GW–15
GW–16
GW–17
GW–18
GW–19
GW–20
GW–21
GW–22
GW–23
GW–24
GW–25
GW–26
GW–27
GW–28
GW–29
GW–30
GW–31
GW–32
GW–33
NORTH
LEGEND:
GW–29 Trench PDI Groundwater Sampling Location
Vinyl Chloride Concentration (ug/L)
Depth (ft) below ground surface
Vinyl Chloride ICL (2 ug/L)
XDD
STRATEGIC. ENVIRONMENTAL. SOLUTIONS.
SCALE: 1"= 90'
DATE: August 23, 2007
PROJECT NO.: 84411
CLIENT: Dover PRP Group
DRAWN BY: KJW
CHECKED BY: DK
PROJ. MGMT. APPROVAL: MM
TITLE: Air Sparge Trench PDI – VC Results
DRAWING NO.: FIGURE 1–9B
REV: 2

Northwest Landfill Pre-Design
Investigation Results
Maximum THF Concentration
13'–18' = 4,500 ug/L
21'–25' = 1,200 ug/L
NORTH
GW–01
GW–02
GW–03
GW–04
GW–05
GW–06
GW–07
GW–08
GW–09
GW–10
GW–11
GW–12
GW–13
GW–14
GW–15
GW–16
GW–17
GW–18
GW–19
GW–20
GW–21
GW–22
GW–23
GW–24
GW–25
GW–26
GW–27
GW–28
GW–29
GW–30
GW–31
GW–32
GW–33
LEGEND:
GW–29 Trench PDI Groundwater Sampling Location
THF Concentration (ug/L)
Depth (ft) below ground surface
THF ICL (154 ug/L)
XDD
STRATEGIC. ENVIRONMENTAL. SOLUTIONS.
SCALE: 1"= 90'
DATE: August 22, 2007
PROJECT NO.: 84411
CLIENT: Dover PRP Group
DRAWN BY: KJW
CHECKED BY: DK
PROJ. MGMT. APPROVAL: MM
TITLE: Air Sparge Trench PDI – THF Results
DRAWING NO.: FIGURE 1–9C
REV: 2

1.4.9.2.2 Toe of Landfill

During the Winter 2006 EMP monitoring event, 19 of the wells located along the downgradient toe of the Landfill, from the SC-11 couplet in the west to the SC-7 nest and well B-2U in the east, were sampled. Table 1-6 summarizes the results of a subset of EMP monitoring events with regard to applicable ICLs established in the AROD. The primary COCs identified above ICLs at the toe of the Landfill include arsenic, benzene, VC, and THF.

Of the 14 VOC constituents for which ICLs were established in the AROD, 4 were detected along the toe of the Landfill at concentrations above applicable ICLs during the Winter 2006 EMP event. Benzene and arsenic were detected at concentrations above their ICLs with the greatest frequency (both in 13 out of 19 wells). VC (3 out of 19 wells) and THF (4 out of 19 wells) were detected at concentrations above their ICLs less frequently. Benzene and arsenic were generally detected along the full length of the toe of the Landfill. THF was detected in the vicinity of the western-most toe of the Landfill. VC was primarily detected in the vicinity of the eastern toe of the Landfill. Figure 1-10 is a cross-section that includes the locations of 19 wells along the toe of the Landfill and presents the results of the three recent sampling events for these wells (May 2005, June 2006, and October/November 2006).

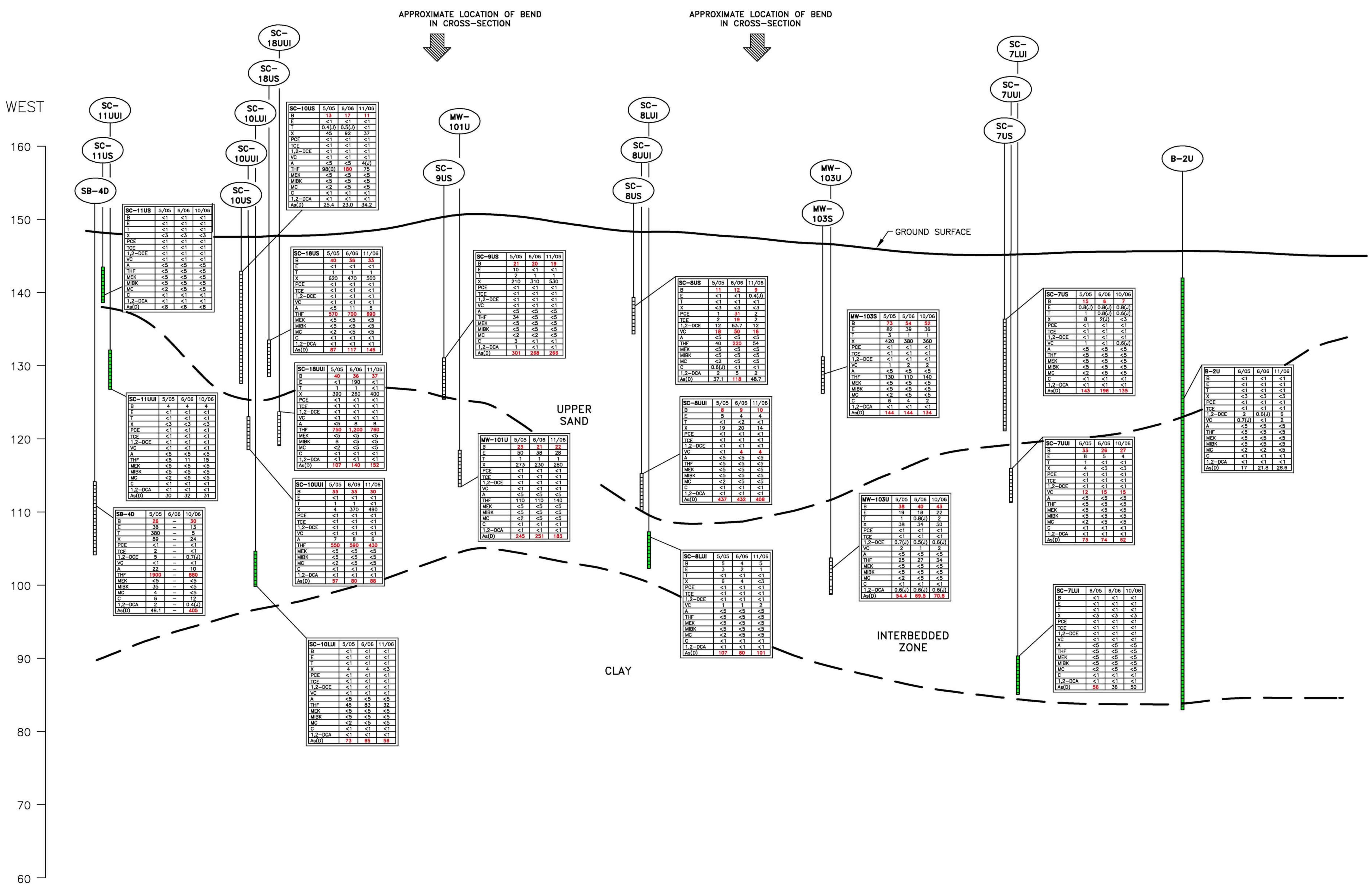
1.4.9.2.3 Southwest Corner of the Landfill

Southern Plume Phase I PDI investigation activities identified the general extent of VOC impacts in ground water located to the south of the western portion of the Landfill. The plume is generally located at depths between approximately 35 and 50 feet BGS, within the UUI stratigraphic unit. The dissolved plume located in the UUI stratigraphic unit extends a distance of approximately 600 feet south of the western toe of the Landfill (approximately 150 feet south of well nest SB-B). VOCs were detected in samples of ground water obtained from locations within the eastern portion of the Southern Plume Study Area at concentrations

TABLE 1-6
SUMMARY OF GROUND WATER QUALITY DATA - ARSENIC AND VOCS
MONITORING WELLS LOCATED ALONG THE TOE OF THE LANDFILL
DOVER MUNICIPAL LANDFILL
DOVER, NEW HAMPSHIRE

CONSTITUENT	ICL (ug/l)	December 1995		December 1997		December 2001		December 2004		June 2006		October/November 2006	
		# Wells > ICL	Range (ug/L)	# Wells > ICL	Range (ug/L)	# Wells > ICL	Range (ug/L)	# Wells > ICL	Range (ug/L)	# Wells > ICL	Range (ug/L)	# Wells > ICL	Range (ug/L)
Arsenic	50	5/12	63.3 - 132	9/14	55 - 248	14/19	51 - 484	14/19	51.2 - 466	13/18	65 - 432	13/19	56 - 408
Benzene	5	14/18	8 - 66	15/19	10 - 67	14/19	7 - 65	13/19	7 - 70	12/18	9 - 54	13/19	7 - 52
1,1-DCE	7(5)	0/18(15)	-----	0/18	-----	0/19	-----	0/19	-----	0/18	-----	0/19	-----
1,2-DCA	5	0/18(15)	-----	1/18	6	0/19	-----	0/19	-----	0/18	-----	0/19	-----
Methylene Chloride	5	2/18	64 - 740	8/19	6 - 66	0/19	-----	0/19	-----	0/18	-----	0/19	-----
Tetrachloroethene	5	1/18	8	1/19	12	0/19	-----	0/19	-----	1/18	31	0/19	-----
Trichloroethene	5	1/18	9	1/19	13	1/19	7	0/19	-----	1/18	19	0/19	-----
Vinyl Chloride	2	4/18	3(J) - 16	5/19	3 - 33	4/19	4 - 21	3/19	9 - 26	3/18	4 - 50	3/19	4 - 16
cis-1,2-DCE	70(5)	1/18	72	2/19	96 - 282	0/19	-----	0/19	-----	0/18	-----	0/19	-----
Chloroethane	14,000	0/18	-----	0/19	-----	0/19	-----	0/19	-----	0/18	-----	0/19	-----
Tetrahydrofuran	154(5)	9/18	220 - 3,400	7/19	170 - 1,600	5/19	200 - 1,200	4/19	810 - 1,700	5/18	180 - 1,200	4/19	430 - 880
Acetone	700	1/18	8,800	1/19	3,400	0/19	-----	0/19	-----	0/18	-----	0/19	-----
MEK	200	1/18	7,500	1/19	1,900	0/19	-----	0/19	-----	0/18	-----	0/19	-----
MIBK	350	1/18	3,000	1/19	990	0/19	-----	0/19	-----	0/18	-----	0/19	-----
Toluene	1,000	0/18	-----	0/19	-----	0/19	-----	0/19	-----	0/18	-----	0/19	-----

Notes:
1. 3/18 = constituent was detected at a concentration above applicable ICL in ground water samples obtained from 3 of the 18 wells along the toe of the Landfill.
2. J = an estimated value; constituent was detected at a concentration below the laboratory quantitation limit.
3. B = constituent detected in laboratory method blank.
4. ICL = Interim Cleanup Standard as established by the Amended Record of Decision.
5. The NHDES Ambient Groundwater Quality Standard (AGQS) was used for THF, 1,1,-DCE and cis-1,2-DCE.
6. ug/L = micrograms per liter (parts per billion).
7. Wells included in evaluation are screened in the upper sand (US), upper upper-interbedded (UUI), and lower upper-interbedded (LUI) stratigraphic units.
8. Concentration range presented is for only those wells that were above applicable ICL.
9. Results for wells SC-10UUI and SC-18UUI were not counted for those constituents that were not detected above a method detection limit that was higher than the applicable ICL. For example, for well SC-10UUI, vinyl chloride was not detected above a detection limit of 10 ppb, but the ICL for vinyl chloride is 2 ppb. Therefore, the results of the analyses for SC10-UUI are not counted in the summary for vinyl chloride.
10. Wells included in the evaluation: SB-4D, SC-11US/UUI, SC-10US/UUI/LUI, SC-18US/UUI, SC-9US, MW-101U, SC-8US/UUI/LUI, MW-103S/U, SC-7US/UUI/LUI, and B-2U.
11. DCE = Dichloroethene
12. DCA = Dichloroethane.
13. MEK = 2-butanone.
14. MIBK = 4-methyl 2-pentanone.



LEGEND

SC-6US	MONITORING WELL LOCATION AND DESIGNATION
	SCREENED INTERVAL
	INDICATES SCREENED INTERVAL WITH NO VOC VALUES ABOVE THE INTERIM CLEANUP STANDARD.
	APPROXIMATE DEPTH OF STRATIGRAPHIC CHANGE
B 12	INDICATES DETECTED VALUE ABOVE THE INTERIM CLEANUP STANDARD FOR THE CONSTITUENT
TCE <10	INDICATES DETECTION LIMIT IS ABOVE THE INTERIM CLEANUP STANDARD FOR THE CONSTITUENT
C –	CONSTITUENT NOT ANALYZED
MC 10(B)	(B) DENOTES CONSTITUENT WAS ALSO DETECTED IN THE LABORATORY METHOD BLANK
A 3(J)	(J) INDICATES AN ESTIMATED VALUE; CONSTITUENT DETECTED AT A CONCENTRATION BELOW REPORTING LIMIT

ABBREV	CONSTITUENT	INTERIM CLEANUP STANDARD
B	BENZENE	5
E	ETHYLBENZENE	700*
T	TOLUENE	1,000
X	XYLENE	10,000*
PCE	TETRACHLOROETHENE	5
TCE	TRICHLOROETHENE	5
1,2-DCE	1,2-DICHLOROETHENE ((C) = CIS)	70*
VC	VINYL CHLORIDE	2
A	ACETONE	700
THF	TETRAHYDROFURAN	154*
MEK	2-BUTANONE	200
MIBK	4-METHYL-2-PENTANONE	350
MC	METHYLENE CHLORIDE	5*
C	CHLOROETHANE	14,000
1,2-DCA	1,2-DICHLOROETHANE	5
As(D)	ARSENIC (DISSOLVED)	50

* NEW HAMPSHIRE AMBIENT GROUND WATER QUALITY STANDARD

0 150 300
APPROX. SCALE IN FEET

DRAFT

CLIENT: DOVER GROUP				
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE				
TITLE: CROSS SECTION WINTER 2006, ANALYTICAL DATA				
DESIGNED: RSE	DRAWN: NMT	CHECKED: JT	APPROVED: MJW	
SCALE: 1" = 150'	DATE: 1/31/08	FILE NO.: 2009D201	PROJECT NO.: 2009-005	FIGURE NO.: 1-10

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in the single digit µg/L range in the US and UUI strata. VOCs were not detected in samples of ground water obtained from locations within the southern and western portions of the Southern Plume Study Area.

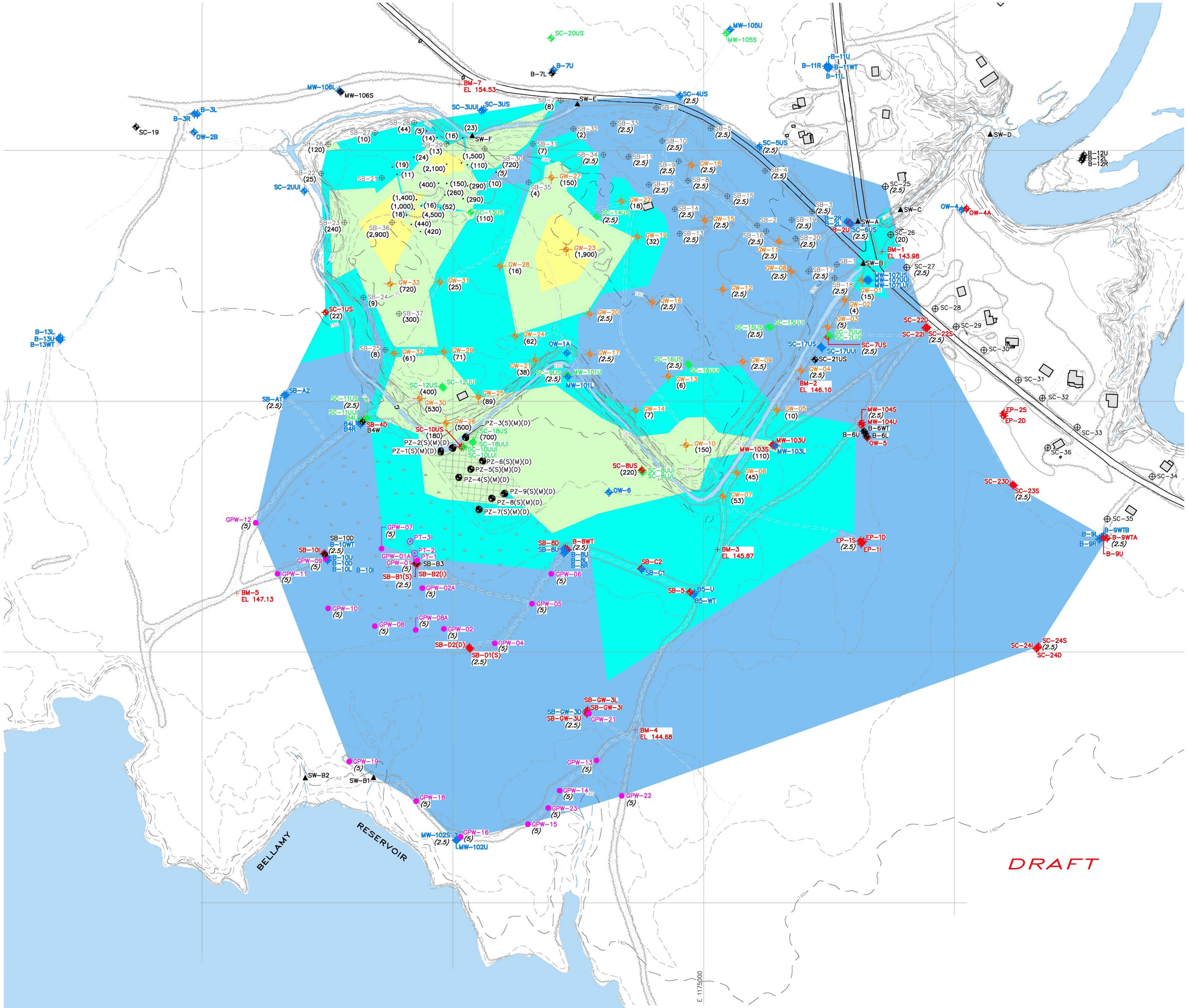
Figure 3B from the Southern Plume PDI Summary Report (GeoInsight, 2007), included in Appendix C, illustrates the approximate extent of dissolved impacts by depth, indicates the analytes detected at each location, and indicates the total VOC concentration.

One uncertainty discussed in the 2004 AROD was the capacity of the air sparging trench to treat elevated concentrations of THF at the southwest corner of the Landfill. To evaluate the general extent of impacts to ground water and to evaluate the approximate center of mass of the plume, THF isoconcentration maps prepared for the Southern Plume Summary report (Figures 9A, 9B, and 9C included in Appendix C; GeoInsight, 2007) were updated using the THF concentrations identified by XDD during Phase I of the Air Sparging Trench PDI. Figures 1-11A, 1-11B, and 1-11C incorporate THF concentrations distributed vertically in the US, UUI, and LUI units. The figures include the Air Sparge Trench Phase I PDI data that were collected from the interior of the Landfill and were mapped using the following conventions:

- the highest THF concentration in samples of ground water collected from depths between 0 and 30 feet BGS were included on the US map;
- the highest THF concentration in samples of ground water collected from depths between 30 and 50 feet BGS were included on the UUI map; and
- the highest THF concentration in samples of ground water collected from depths between 50 and 70 feet BGS were included on the LUI map.

1.4.10 Surface Water Quality Conditions

Between 2000 and 2004, surface water samples were collected from two locations within the perimeter ditch, two locations in the swale, and the culvert located at the north side of the intersection of Tolend and Glen Hill Roads (directly west of the head of the drainage swale;



LEGEND

SC-7US	EMP WELL SAMPLING LOCATION AND DESIGNATION
SC-7UUI	ADDITIONAL WELL SAMPLING LOCATION AND DESIGNATION (DECEMBER 1995 TO PRESENT)
MW-17US	WELL LOCATIONS WHERE EMP WATER LEVELS ARE OBTAINED (IE, EMP SAMPLING IS NOT PERFORMED)
OW-2	WELL LOCATIONS WHERE WATER LEVELS ARE NOT OBTAINED AND SAMPLING IS NOT PERFORMED
SW-A	EMP SURFACE WATER SAMPLING LOCATION
SC-30	SENTINEL WELL LOCATION AND DESIGNATION
SB-2	SOIL BORING LOCATION AND DESIGNATION
650-60	NORTHERN PLUME – SOIL BORING
150	EXISTING TOPOGRAPHIC CONTOUR
	PAVED ROAD
	UNPAVED ROAD OR DRIVE

-N-

LEGEND FOR DATA

GPW-21 (83)	GEOPROBE BORING LOCATION – MICROGRAMS PER LITER (ug/L) (DECEMBER 2006)
SB-35 (4)	SOIL BORING LOCATION – MICROGRAMS PER LITER (ug/L) (DATA FROM 2001)
SC-24D *(2.5)*	EMP WELL SAMPLING LOCATION – MICROGRAMS PER LITER (ug/L) (DATA FROM 2005 AND 2006)
GW-04 *(2.5)*	GEOPROBE BORING LOCATION (ug/L) (DATA FROM JULY 2007)

ITALICIZED DATA REPRESENTS 1/2 THE DETECTION LIMIT

THF-US

COLOR	RANGE BEG.	RANGE END	PERCENT OF AREA	AREA (FT²)
	0	10	61.0	4169152.27
	10	100	23.5	1609279.73
	100	1,000	14.0	957842.52
	1,000	10,000	1.5	100589.46
	10,000	100,000	0.0	0.00
	100,000	300,000	0.0	0.00

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.

2. MONITORING WELL LOCATIONS UPDATED IN NOVEMBER 2007, BASED UPON COMPREHENSIVE SITE SURVEY PERFORMED BY VERMONT SURVEY AND ENGINEERING, INC. OF MONTPELIER, VERMONT.

3. THF CONCENTRATION DATA CONTOURED USING LINEAR TRIANGULATION INTERPOLATION METHODS USING AUTODESK LAND DESKTOP SOFTWARE. SMOOTHING TECHNIQUES WERE NOT APPLIED TO THE DATA SET.

4. THIS FIGURE WAS CREATED BY ADDING ADDITIONAL DATA POINTS TO FIGURE 9A OF THE JUNE 8, 2007, SUMMARY REPORT OF PHASE I ACTIVITIES AND PROPOSED PHASE II ACTIVITIES, SOUTHERN PLUME PRE-DESIGN INVESTIGATION (GEOINSIGHT, 2007).

0 200 400
APPROX. SCALE IN FEET

DRAFT

CLIENT: DOVER GROUP

PROJECT: DOVER LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

TITLE: UPDATED THF
ISOCONCENTRATION MAP – US

DESIGNED:	DRAWN:	CHECKED:	APPROVED:
KEZ	NMT	CAB	MJW

SCALE:	DATE:	FILE NO.:	PROJECT NO.:	FIGURE NO.:
1" = 200'	1/30/08	2009D211	2009-009	1—11A

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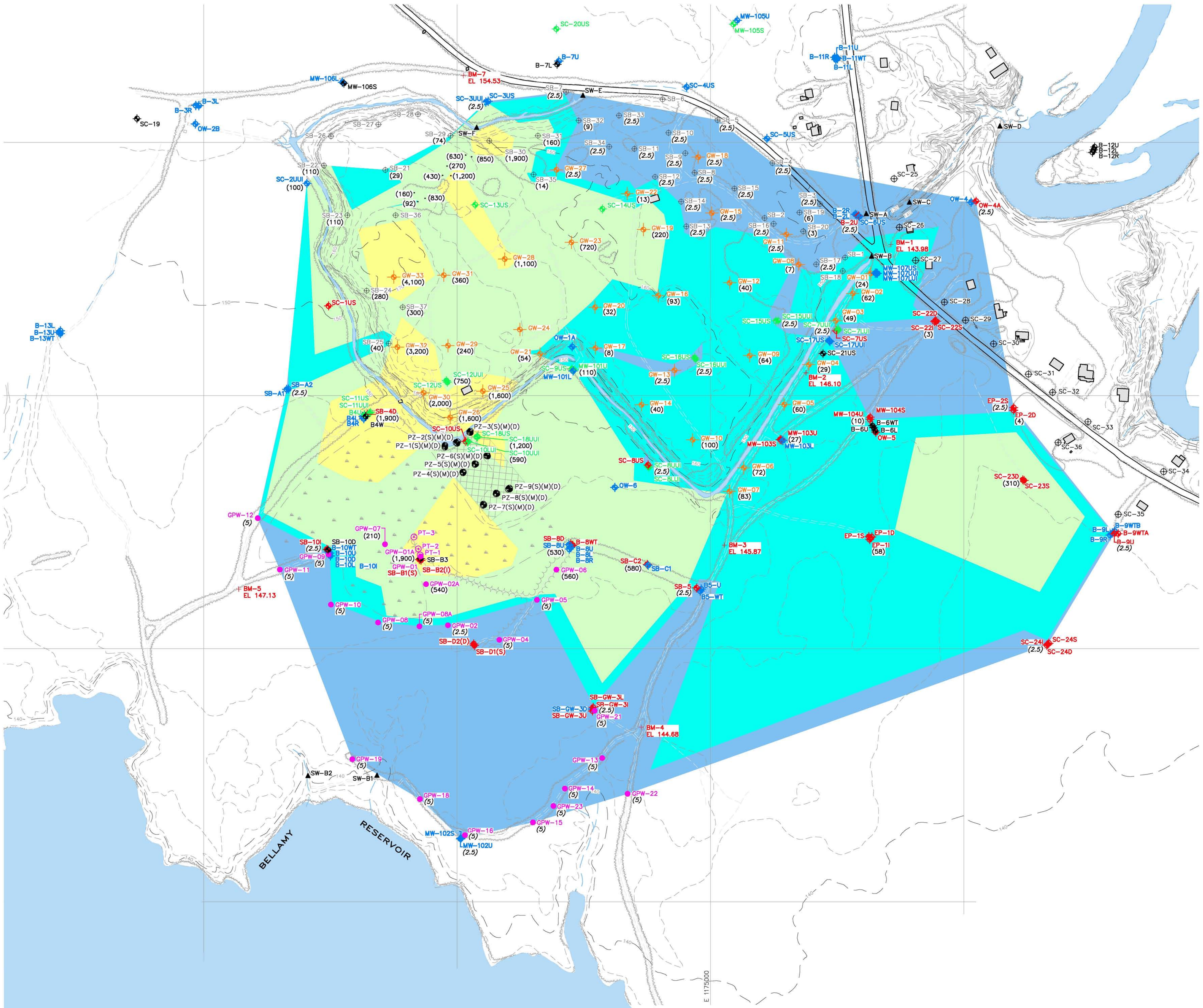

-N-

LEGEND

SC-7US	EMP WELL SAMPLING LOCATION AND DESIGNATION
SC-7UUI	ADDITIONAL WELL SAMPLING LOCATION AND DESIGNATION (DECEMBER 1995 TO PRESENT)
MW-17US	WELL LOCATIONS WHERE EMP WATER LEVELS ARE OBTAINED (IE, EMP SAMPLING IS NOT PERFORMED)
OW-2	WELL LOCATIONS WHERE WATER LEVELS ARE NOT OBTAINED AND SAMPLING IS NOT PERFORMED
SW-A	EMP SURFACE WATER SAMPLING LOCATION
SC-30	SENTINEL WELL LOCATION AND DESIGNATION
SB-2	SOIL BORING LOCATION AND DESIGNATION
650-60	NORTHERN PLUME – SOIL BORING
150	EXISTING TOPOGRAPHIC CONTOUR
	PAVED ROAD
	UNPAVED ROAD OR DRIVE

LEGEND FOR DATA

GPW-21 *(5)*	GEOPROBE BORING LOCATION – MICROGRAMS PER LITER (ug/L) (DECEMBER 2006)
SB-35 (14)	SOIL BORING LOCATION – MICROGRAMS PER LITER (ug/L) (DATA FROM 2001)
SC-24I *(2.5)*	EMP WELL SAMPLING LOCATION – MICROGRAMS PER LITER (ug/L) (DATA FROM 2005 AND 2006)
GW-04 (29)	GEOPROBE BORING LOCATION (ug/L) (DATA FROM JULY 2007)

ITALICIZED DATA REPRESENTS 1/2 THE DETECTION LIMIT

THF–UUI

COLOR	RANGE BEG.	RANGE END	PERCENT OF AREA	AREA (FT^2)
	0	10	28.4	1990023.50
	10	100	34.0	2385198.13
	100	1,000	30.8	2162219.31
	1,000	10,000	6.8	477232.56
	10,000	100,000	0.0	0.00
	100,000	300,000	0.0	0.00

DRAFT

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.

2. MONITORING WELL LOCATIONS UPDATED IN NOVEMBER 2007, BASED UPON COMPREHENSIVE SITE SURVEY PERFORMED BY VERMONT SURVEY AND ENGINEERING, INC. OF MONTPELIER, VERMONT.

3. THF CONCENTRATION DATA CONTOURED USING LINEAR TRIANGULATION INTERPOLATION METHODS USING AUTODESK LAND DESKTOP SOFTWARE. SMOOTHING TECHNIQUES WERE NOT APPLIED TO THE DATA SET.

4. THIS FIGURE WAS CREATED BY ADDING ADDITIONAL DATA POINTS TO FIGURE 9B OF THE JUNE 8, 2007, SUMMARY REPORT OF PHASE I ACTIVITIES AND PROPOSED PHASE II ACTIVITIES, SOUTHERN PLUME PRE-DESIGN INVESTIGATION (GEOINSIGHT, 2007).

0 200 400
APPROX. SCALE IN FEET

CLIENT: DOVER GROUP

PROJECT: DOVER LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

TITLE: THF ISOCONCENTRATION MAP – UUI

DESIGNED:	DRAWN:	CHECKED:	APPROVED:
KEZ	NMT	CAB	MJW

SCALE:	DATE:	FILE NO.:	PROJECT NO.:	FIGURE NO.:
1" = 200'	1/31/08	2009D212	2009-009	1—11B

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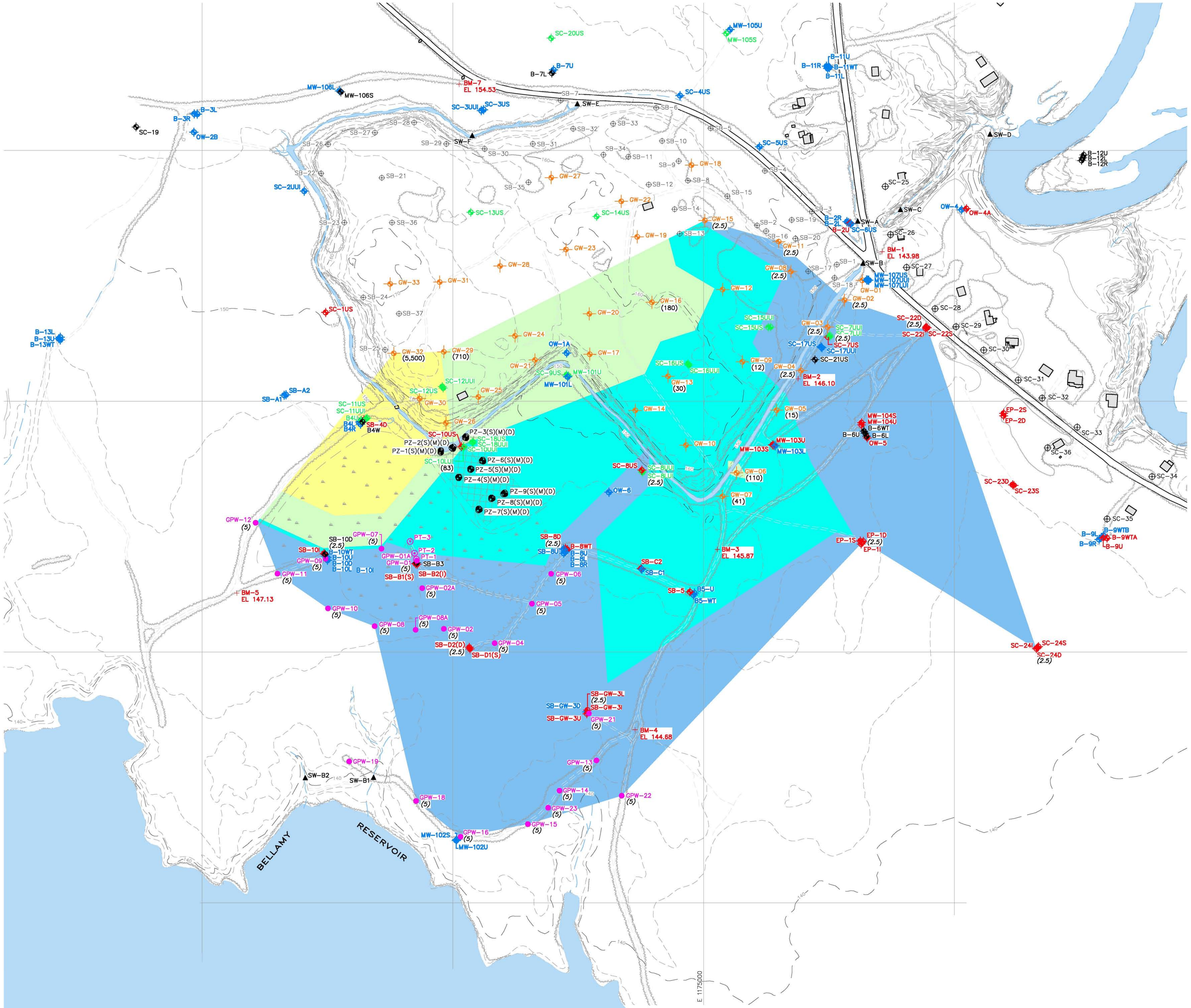


-N-

LEGEND

SC-7US	EMP WELL SAMPLING LOCATION AND DESIGNATION
SC-7UUI	ADDITIONAL WELL SAMPLING LOCATION AND DESIGNATION (DECEMBER 1995 TO PRESENT)
MW-17US	WELL LOCATIONS WHERE EMP WATER LEVELS ARE OBTAINED (IE, EMP SAMPLING IS NOT PERFORMED)
OW-2	WELL LOCATIONS WHERE WATER LEVELS ARE NOT OBTAINED AND SAMPLING IS NOT PERFORMED
SW-A	EMP SURFACE WATER SAMPLING LOCATION
SC-30	SENTINEL WELL LOCATION AND DESIGNATION
SB-2	SOIL BORING LOCATION AND DESIGNATION
650-60	NORTHERN PLUME – SOIL BORING
150	EXISTING TOPOGRAPHIC CONTOUR
	PAVED ROAD
	UNPAVED ROAD OR DRIVE

LEGEND FOR DATA

GPW-21 *(5)*	GEOPROBE BORING LOCATION – MICROGRAMS PER LITER (ug/L) (DECEMBER 2006)
SB-35 (4)	SOIL BORING LOCATION – MICROGRAMS PER LITER (ug/L) (DATA FROM 2001)
SC-24D *(2.5)*	EMP WELL SAMPLING LOCATION – MICROGRAMS PER LITER (ug/L) (DATA FROM 2005 AND 2006)
GW-04 *(2.5)*	GEOPROBE BORING LOCATION (ug/L) (DATA FROM JULY 2007)

ITALICIZED DATA REPRESENTS 1/2 THE DETECTION LIMIT

THF–LUI

COLOR	RANGE BEG.	RANGE END	PERCENT OF AREA	AREA (FT^2)
	0	10	50.4	2127992.86
	10	100	31.2	1317633.95
	100	1,000	12.5	529279.58
	1,000	10,000	5.9	251070.11
	10,000	100,000	0.0	0.00
	100,000	300,000	0.0	0.00

DRAFT

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.

2. MONITORING WELL LOCATIONS UPDATED IN NOVEMBER 2007, BASED UPON COMPREHENSIVE SITE SURVEY PERFORMED BY VERMONT SURVEY AND ENGINEERING, INC. OF MONTPELIER, VERMONT.

3. THF CONCENTRATION DATA CONTOURED USING LINEAR TRIANGULATION INTERPOLATION METHODS USING AUTODESK LAND DESKTOP SOFTWARE. SMOOTHING TECHNIQUES WERE NOT APPLIED TO THE DATA SET.

4. THIS FIGURE WAS CREATED BY ADDING ADDITIONAL DATA POINTS TO FIGURE 9C OF THE JUNE 8, 2007, SUMMARY REPORT OF PHASE I ACTIVITIES AND PROPOSED PHASE II ACTIVITIES, SOUTHERN PLUME PRE-DESIGN INVESTIGATION (GEOINSIGHT, 2007).

0 200 400
APPROX. SCALE IN FEET

CLIENT: DOVER GROUP				GeoInsight Practical in Nature
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE				
TITLE: THF ISOCONCENTRATION MAP – LUI				
DESIGNED: KEZ	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW	
SCALE: 1" = 200'	DATE: 1/30/08	FILE NO.: 2009D213	PROJECT NO.: 2009-009	FIGURE NO.: 1–11C

locations SW-A through SW-E shown on Figures 1-2 and 1-5). A summary of historical surface water quality at Stations SW-A to SW-E was presented in the 2004 RFFS (Section 1.3.7, pages 1-70 to 1-73). As part of the 2005 Northwest Landfill and 2006 Southern Plume PDIs, additional surface water stations were established in the north perimeter ditch (SW-F), in shallow tributaries that drain the wetland to the Bellamy Reservoir (SW-1, SW-2, SW-3, SW-6, SW-B1, and SW-B2), and along the northern shore of the Bellamy Reservoir (SW-2, SW-4, SW-5, SW-7, and SW-8).

VOCs were historically detected in the surface water samples collected from the perimeter ditch, swale, and in the Cocheco River at the mouth of the swale. Historically, the highest concentrations of VOCs were detected in EMP samples of surface water collected from the north portion of the perimeter ditch (location SW-E) and the drainage culvert located at the intersection of Tolend and Glen Hill Roads (SW-A; Figures 1-2 and 1-5). During the Northwest Landfill PDI, ten surface water samples were collected from the perimeter ditch, between Stations SW-E and SW-F. Results are summarized in Table 1-7. After the Northwest Landfill PDI was completed, the highest concentrations of VOCs in surface water were identified in the vicinity of location SW-F. VOCs detected in the surface water samples included generally the same suite of compounds identified in shallow ground water in the Northwest Landfill hotspot (see Table 1-7). VOCs were not detected in the surface water samples collected from the Bellamy Reservoir during the RI and FES. Additional surface water samples collected from the Bellamy Reservoir and its tributaries west and south of the Landfill in 2005 and 2006 as part of EMP events did not contain VOCs (see results in Appendix B).

The EMP samples and surface water samples were also analyzed for arsenic and iron (total and dissolved). Concentrations of dissolved iron in the surface water samples obtained from the five sampling locations SW-A to SW-E and from the newer sampling locations SW-B1, SW-B2, SW-F, SW-6, and SW-7 were above New Hampshire SWQSs for fresh water-chronic exposures (1,000 μg/L). Concentrations of dissolved arsenic in these ten samples were below New Hampshire SWQSs for fresh water-acute (340 μg/L) and fresh

TABLE 1-7
SUMMARY OF LABORATORY ANALYTICAL RESULTS
SURFACE WATER
DOVER MUNICIPAL LANDFILL
DOVER, NEW HAMPSHIRE

Well ID			ND-SW-0-12-05-05	ND-SW-100-12-05-05	ND-SW-200-12-05-05	ND-SW-275-12-06-05*	ND-SW-300-12-06-05*	ND-300-DUP*	ND-SW-425-12-06-05*	ND-SW-425	ND-SW-500-12-06-05	ND-SW-850
SDG			SDG-ND-1	SDG-ND-1	SDG-ND-1	SDG-ND-2	SDG-ND-2	SDG-ND-2	SDG-ND-2	SDG-ND-18	SDG-ND-2	SDG-ND-18
Dilution Factor			1	1	1	5	5	5	5	5	1	1
Date	NH SW	NH SW	12/5/2005	12/5/2005	12/5/2005	12/6/2005	12/6/2005	12/7/2005	12/6/2005	1/6/2006	12/6/2005	1/6/2006
VOCs (USEPA 8260B)	**Fresh Water-Acute**	**Fresh Water-Chronic**										
benzene	**5,300**	---	<20	<40	<50	<10	<10	<10	<10	<10	<2	**4.8**
ethylbenzene	**32,000**	---	**60**	**80**	**130**	**130**	**120**	**120**	**200**	**160**	**2.9**	**13**
toluene	---	---	**760**	**1,000**	**1,700**	**1,500**	**1,400**	**1,500**	**2,500**	**1,700**	**16**	<2
xylenes	---	---	**280**	**370**	**540**	**530**	**520**	**520**	**850**	**680**	**6.0**	**13.8**
tetrachloroethene (PCE)	**5,280**	**840**	**42**	**60**	**99**	**100**	**98**	**98**	**140**	**65**	<2	<2
trichloroethene (TCE)	**45,000**	**21,900**	<20	<40	<50	**39 J**	**37**	**39**	**54**	**33**	<2	<2
1,2-dichloroethene (DCE)	**11,600**	---	**2,700**	**3,700**	**6,000**	**5,700****	**5,300****	**5,700****	**11,000****	**5,100****	<2	<2
vinyl chloride	---	---	**170**	**210**	**340**	**330**	**310**	**320**	**610**	**440**	<2	<2
acetone	---	---	**100**	<200	**270**	**280**	**270**	**240**	**380**	**260**	<10	<10
tetrahydrofuran (THF)	---	---	<100	<200	<300	<50	<50	<50	<50	**54**	<10	<10
2-butanone (MEK)	---	---	**580**	**800**	**1,400**	**1,300**	**1,200**	**1,200**	**1,800**	**1,000**	<10	<10
4-methyl 2-pentanone (MIBK)	---	---	**340**	**460**	**760**	**740 J**	**720**	**680 J**	**1,100 J**	**660**	<10	<10
methylene chloride	**11,000**	---	**370**	**480**	**800**	**770**	**740**	**770**	**1,400**	**590**	<5	<5
1,1,1-trichloroethane (TCA)	---	---	**75**	**96**	**160**	**150**	**140**	**150**	**260**	**200**	<2	<2
1,1-dichloroethane	---	---	**83**	**110**	**180**	**170**	**160**	**170**	**280**	**180**	**4.8**	<2
1,1-dichloroethene	**11,600**	---	<10	<20	<30	**6.9**	**6.4**	**6.8**	**12**	**5.6**	<1	<1
1,2-dichloroethane	**118,000**	**20,000**	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
bromomethane	**11,000**	---	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
chloromethane	**11,000**	---	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
chloroform	**28,900**	**1,240**	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
dibromochloromethane	**11,000**	---	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
bromoform	**11,000**	---	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
carbon disulfide	---	---	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
styrene	---	---	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
chloroethane	---	---	<20	<40	<50	**14**	**12**	**12**	**20**	**26**	**3.9**	<2
chlorobenzene	**250**	**50**	<20	<40	<50	<10	<10	<10	<10	<10	<2	**3.6**
1,2-dichloropropane	**23,000**	**5,700**	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
1,1,2-trichloroethane	---	**9,400**	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
cis-1,3-dichloropropene	**6,060**	**244**	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
trans-1,3-dichloropropene	**6,060**	**244**	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
1,1,2,2-tetrachloroethane	**9320**	**2400**	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
2-hexanone	---	---	<100	<200	<300	**71 J**	**69**	**65 J**	**100 J**	**51**	<10	<10
1,2,4-trimethylbenzene	---	---	**38**	**50**	**60**	**59 J**	**62**	**55**	**92**	**90**	**2.5**	**7.3**
1,2-dibromoethane			<20	<40	<50	<10	<10	<10	<10		<2	<2
1,2-dichlorobenzene	**1120**	**763**	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
1,3,5-trimethylbenzene	---	---	<20	<40	<50	**16**	**19**	**15**	**29**	**24**	<2	<2
1,3-dichlorobenzene			<20	<40	<50	<10	<10	<10	<10		<2	<2
1,4-dichlorobenzene	**1120**	**763**	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
bromodichloromethane			<20	<40	<50	<10	<10	<10	<10		<2	<2
carbon tetrachloride			<20	<40	<50	<10	<10	<10	<10		<2	<2
dichlorodifluoromethane (freon 12)	**11,000**	---	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
methyl t-butyl ether (MTBE)			<20	<40	<50	<10	<10	<10	<10		<2	<2
trichlorofluoromethane (freon 11)	**11,000**	---	<20	<40	<50	**15**	**13**	**15**	**23**	**14**	<2	<2
NON-TARGET ANALYTES												
4-isopropyltoluene	---	---	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2
diethyl ether	---	---	<100	<200	<300	<50	<50	<50	<50	<50	<10	<10
isopropylbenzene	---	---	<20	<40	<50	<10	<10	<10	<10	<10	<2	**4**
naphthalene	**2,300**	**620**	<50	<100	<100	<30	<30	<30	<30	<30	<5	**6.1**
n-propylbenzene	---	---	<20	<40	<50	<10	<10	<10	**12**	**12**	<2	<2
sec-butylbenzene	---	---	<20	<40	<50	<10	<10	<10	<10	<10	<2	<2

Notes:
1. Results reported in micrograms per liter (ug/L).
2. "Combined" results represent a composite of data from analytical runs with varying dilution factors.
3. Dup = submitted for laboratory duplicate analysis.
4. NH SW - New Hampshire Department of Environmental Services (NHDES) surface water standard (Env-Ws 1700). These NHDES fresh water standards (which are ARARs) are applicable threshold values that are based upon federal Ambient Water Quality Criteria (AWQC).
Federal AWQC values for priority toxic pollutants and non priority pollutants were reviewed to evaluate whether federal standards were available for compounds that do not have NHDES standards. However, additional federal AWQCs were not identified.
5. --- = NH SW not established.
6. < = not detected above practical quantitation limits (PQLs).
7. Bold values exceed laboratory PQLs.
8. "J" denotes an estimated value; constituent detected at a concentration below PQL or represents a data validation qualifier.
7. "E" denotes that the analytical result was outside the calibration range of the insturment and is an estimate.
9. Yellow highlight indicates an issue with the chain of custody.
9. Xylenes results represent the sum of m-, p-, and o-xylene concentrations.
10. DCE results represent the sum of trans- and cis-DCE concentrations.
11. "*" denotes well ID name has been changed from what was reported on the laboratory analytical reports.
12. "**" denotes data from an analytical run with a higher dilution factor; results were initially outside the instrument calibration range.
14. SDG = Sample Delivery Group.

water-chronic (150 µg/L) exposures. Tables that summarize the results of historical EMP surface water sampling events are included in Appendix B of this SC-FFS.

Surface water samples were collected during the October/November 2006 EMP monitoring event from five surface water stations SW-A, SW-B, SW-C, SW-D, and SW-E. The surface water sampling locations are illustrated on Figure 1-2. Analytical results for the surface water samples are provided in Appendix B.

1.4.11 Sediment Quality and Conditions

After the 1991 ROD was issued, sediment samples were collected as part of the 1993 PDI and the 1998 Trench and Swale Characterization. Sediment samples were collected from the perimeter ditch, the swale, and the Cocheco River. The results of these activities were summarized in the 2004 RFFS (Section 1.3.8, pages 1-73 to 1-74). Results associated with the November 2002 Updated Ecological Risk Assessment indicated that concentrations of arsenic exceeded the USEPA Ecotox Threshold (USEPA, 1996) screening level. Therefore, additional evaluation was performed in the 2006 Ecotoxicity PDI that is summarized in the Draft Focused Ecotoxicity and Human Health Assessment Activities Cocheco River, Dover Municipal Landfill Superfund Site, prepared by GeoInsight and dated August 16, 2006. As part of Phase I of the Air Sparge Trench PDI, 15 sediment samples were collected from the perimeter ditch (designated SD-1 to SD-11) and the swale (designated SD-12 to SD-15) for analysis of arsenic. The locations of the sediment samples are illustrated on Figure 1-5 and the results are summarized on Table 1-8. Arsenic concentrations ranged from 4.9 mg/Kg to 314 mg/Kg. Of the 15 samples, 9 sediment samples contained arsenic above 50 mg/Kg. The areas of the ditch and swale identified to contain sediment with concentrations of arsenic exceeding 50 mg/Kg will be addressed as part of the SC remedy by removal prior to backfilling the perimeter ditch.

TABLE 1-8
Summary of Arsenic Concentrations in Sediment - Ditch and Swale
Dover Municipal Landfill Superfund Site
Dover, New Hampshire

Sampling Location	Sample Date	Arsenic (mg/Kg drywt)
SD-01	7/25/2007	**69.9**
SD-02	7/25/2007	**140**
SD-03	7/25/2007	**59.8**
SD-04	7/25/2007	**314**
SD-05	7/25/2007	48
SD-06	7/25/2007	**86.3**
SD-07	7/25/2007	**67.9**
SD-08	7/25/2007	21.4
SD-09	7/25/2007	11.4
SD-10	7/25/2007	4.88
SD-11	7/25/2007	**61.4**
SD-12	7/25/2007	46.2
SD-13	7/25/2007	**277**
SD-14	7/25/2007	18.5
SD-15	9/11/2007	10.6 J

ICL for Arsenic= 50 mg/Kg drywt.

Notes:
1. mg/Kg drywt = Milligrams per kilogram dry weight (ppm).
2. ICL = Interim Cleaneup Levels.
4. J = Estimated value. The analyte was detected in the sample at a concentration less than the laboratory Practical Quantitation Limit (PQL), but above the Method Detection Limit (MDL).
5. Values in blue exceed the ICL.

1.4.12 Air Sampling and Analyses

The 2004 RFFS included a detailed discussion of air sampling and analyses (Section 1.3.9, pages 1-74 to 1-77) completed during the RI/FS, FES, PDI, and Trench and Swale Characterization Study. Air sampling activities completed during the RI were summarized in Section 6 and Appendix D of the RI report. Air sampling activities completed during the FES were summarized in Section 1.2.3 of the FS report (page 1-35 and Table 1-12 of the FS report) and Section 1.3.9 of the 2004 RFFS (pages 1-74 to 1-77). Additional air monitoring performed by Golder during the PDI did not identify unacceptable risks to human health in air within the Landfill footprint (Golder, 1995, pages 73 through 86).

Since the 2004 RFFS was prepared, GeoInsight implemented the SVI PDI Work Plan (GeoInsight, 2006) in September 2006 to evaluate the potential for vapor intrusion into residential structures located downgradient of the Landfill along Glen Hill and Tolend Roads. An indoor air exposure pathway was not identified based upon the results of quarterly ground water monitoring activities (GeoInsight, 2007, pages 4 through 6).

2.0 UPDATED RISK CHARACTERIZATION

2.1 SUMMARY

2.1.1 Overview

A detailed summary of previous risk characterization activities conducted at the Site is presented in the 2004 RFFS, Section 2.0. The USEPA, in its 2004 RFFS Addendum, accepted the presentation of risks in the 2004 RFFS. The risk discussion presented in this document is focused upon conditions within and at the perimeter of the Landfill footprint. The risk characterization documented in the 1991 FS was updated in the 2004 RFFS to reflect then-current conditions at the Landfill. The characterization was based upon evaluations completed in the 1991 FS, but revised and updated to reflect then-available (2004) toxicological information and environmental data. The majority of potential human health risk is associated with the presence of dissolved arsenic in ground water. This risk is considered potential, rather than current, because the Landfill area is served by municipal water and is subject to the institutional controls described in Section 1.4.3 of this SC-FFS, which, together, effectively eliminate the use of ground water as a drinking water source, the primary human health exposure pathway identified in the risk assessments.

Conditions at the Landfill have not changed significantly since the 2004 RFFS was prepared, and, therefore, the risk summary presented in Section 2.0 of the RFFS (starting on Page 2-1) is considered to reflect current conditions at the Site. Conclusions of that analysis are generally pertinent to conditions within and at the perimeter of the Landfill footprint, which is the focus of this SC-FFS. Updated risk characterization data relevant to SC are presented in this section and include the findings of the recently completed Phase I of the Air Sparge Trench PDI and of Northwest Landfill PDI.

2.1.2 Interim Cleanup Levels

According to the ROD for the Site issued by the USEPA on September 10, 1991, ICLs were established for the COCs identified during the baseline risk assessment that were found to pose an unacceptable risk to human health or the environment. These risks were posed by the potential future ingestion of ground water to the southeast of the Landfill. The USEPA based the ICLs upon applicable State Ambient Groundwater Quality Standards (AGQSs) and relevant federal Maximum Contaminant Levels (MCLs) and MCL Goals (MCLGs) as ARARs. The ICLs were updated in the 2004 AROD to reflect a revised AGQS for arsenic. Table 2-1 lists the COCs and their corresponding ICLs.

2.2 UPDATED RISK ASSESSMENT

2.2.1 Human Health Risk Assessment

2.2.1.1 Recent Ground Water Quality Testing

Semi-annual EMP ground water monitoring events have been performed at the Landfill since 1994. During these sampling events, ground water samples obtained from 29 monitoring wells located to the south and southeast of the Landfill were analyzed for VOCs and metals. In addition, since December 1995, ground water samples collected from the 8 wells located within the Landfill and 12 additional wells located along the downgradient toe of the Landfill have also been analyzed. Data obtained during the EMP events performed since collection of the data sets referenced in the 2004 RFFS (Section 1.3.5 of the 2004 RFFS [pages 1-57 to 1-66]) were consistent with historical information regarding conditions within and immediately downgradient of the Landfill footprint (see Table 1-5 and Appendix B).

The results of the Trench PDI with regard to VOC impacts within the Landfill footprint and at its perimeter (arsenic concentrations were not evaluated in the direct-push sampling program) were generally consistent with historical data obtained from EMP monitoring of wells at locations SC-12, SC-13, SC-14, SC-15, and SC-16, within the Landfill footprint, and

TABLE 2-1
GROUND WATER CLEANUP LEVELS
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

Constituent	1991 ICL (ug/l)	2004 AROD ICL (ug/l)
Arsenic	50	10
Vinyl chloride	2	2
Benzene	5	5
Trichloroethane	5	5
Tetracholoroethene	5	5
Methylene chloride	5	5
1,1 DCE	7	7
1,2 DCA	5	5
cis-1,2 DCE	70	70
Chloroethane	14,000	14,000
Tetrahydrofuran	154	154
Acetone	700	700
MEK	200	200
MIBK	350	350
Toluene	1,000	1,000

Notes:
1. ICL = Interim Cleanup Level
2. ICL's summarized from page 74 of the 2004 Amended Record of Decision (AROD).

from wells located immediately downgradient of the Landfill toe. In general, benzene and VC were detected at concentrations above their respective ICLs. At locations within the western portion of the Landfill footprint, THF was also detected at concentrations above its ICL, consistent with data obtained from wells immediately downgradient of the western portion of the Landfill.

The Northwest Landfill PDI detected an area of impacted ground water north and west of well SC-13US containing elevated concentrations of VOCs above ICLs. The estimated area of these localized impacts totals approximately 120,000 square feet based upon the estimated area impacted by concentrations of cDCE above 70 ug/L. Based upon the fact that established ICLs are exceeded in ground water in this area of the Landfill, it is reasonable to conclude that conditions in this area pose an unacceptable potential human health risk associated with ingestion of impacted ground water without performing updated risk calculations.

2.2.2 Updated Ecological Risk Assessment

An ecological risk assessment was performed to evaluate potential ecological risks associated with surface water and sediment quality in surface waterways in the vicinity of the Site. As described in the Ecological Risk Assessment Field Report presented in Appendix I-3 of the 2004 RFFS, arsenic, a Site COC, was the primary focus of the assessment of surface water and sediment quality. Arsenic will co-precipitate with iron to form a rust colored precipitate when ground water discharges to the surface and is exposed to atmospheric oxygen. Photographs, field data sheets, and analytical data from surface water and sediment testing were presented in Appendix I-3 of the 2004 RFFS. In addition to surface water and sediment, soil quality on the Landfill was also evaluated for potential ecological risks. The quality of soil on the Landfill was evaluated with regards to potential methane gas emissions.

As discussed in Section 1.3.7 of the 2004 RFFS (pages 1-70 through 1-73), arsenic concentrations detected in surface water samples collected from the perimeter ditch along the

Landfill toe did not exceed SWQCs, both acute and chronic, for fresh water, nor did they exceed the terrestrial wildlife benchmark for surface water.

During Phase I of the Trench PDI, sediment samples were collected from 11 locations in the perimeter ditch located along the Landfill toe and three locations in the swale (Table 1-7). Arsenic concentrations measured in seven of these samples from the perimeter ditch and one sample from the swale exceeded the ICL for arsenic in sediment of 50 mg/Kg, which was established in the 1991 ROD (and affirmed in the 2004 AROD) to be protective of wildlife.

2.2.3 Landfill Gas Phytotoxicity

As discussed in Section 2.2.3 of the 2004 AROD (pages 84 through 86), the results of PDI investigations performed by Golder and supplementary screening performed by Envirogen indicated that the Landfill was not generating quantities of methane and associated gases and emissions that could pose a risk to ecological receptors. The 1995 Golder PDI Report (page 85) indicated that methane and landfill gas production was expected to have peaked within five to ten years after closure of the Landfill in 1978. Given the additional lapsed time since Golder's Report in 1995, it is reasonable to conclude that conditions related to methane and landfill gas production have further moderated, reducing the associated potential ecological risk.

2.3 ANALYSIS OF CURRENT SITE CONDITIONS

The interim risk mitigation measures and institutional controls described in Section 2.4 and Section 2.5 of the 2004 RFFS (pages 2-2 through 2-26) remain in place, effectively mitigating human health risk associated with potential ingestion of ground water.

Additional development or installation of wells for purposes other than those authorized by ordinance has not occurred within the vicinity of the Landfill since the ordinances and overlay district were established. In addition, the areas included in the overlay district or within jurisdiction of the ordinances consist predominantly of forested wetlands. As foreseen in Section 2.7 of the 2004 RFFS (pages 2-29 to 2-32), because of limitations on development activities in wetlands and related septic system requirements, there has not been development in these areas. With the exception of several small lots located to the south along Tolend Road, the City owns the land located to the south and southeast of the Landfill and, therefore, has control over its future use.

Because there are no currently complete exposure pathways associated with ground water impacts within the Landfill footprint, those impacts do not pose current risks. Risks associated with potential future ingestion of ground water were summarized in Table 2-8 of the 2004 RFFS along with current calculated risks for potential exposures to surface water, sediment, and outdoor air. Current risks associated with worst-case surface water conditions (i.e., in the vicinity of EMP Station SW-E) were within the acceptable range for Superfund sites for both carcinogenic and non-carcinogenic risk. Current risks associated with worst-case arsenic concentrations in sediment from the Cocheco River were also within the acceptable range for both carcinogenic and non-carcinogenic risk. Carcinogenic risks associated with outdoor air exposures were calculated by Golder in the 1995 PDI report (Golder, 1995) and found to be within the acceptable range for Superfund sites; Golder further expected that risks would decline with time as the rate of landfill gas generation decreased.

Since the updated risk characterization was reported in the 2004 RFFS, new information obtained regarding ground water and sediment quality within and at the toe of the Landfill is generally consistent with historical information with regard to the types and distribution of COCs detected. The exception is in the Northwest Landfill area within which ground water impacts significantly (several orders of magnitude) higher than detected elsewhere within the Landfill and on the Site in general were detected in a relatively discrete area of approximately 25,000 to 75,000 square feet. Conditions in this hotspot area pose potentially significant implications for SC efforts at the Site, given its location at a distance from the planned SC operations, the concentrations present, and the relatively slow rates of migration from the hotspot to the planned areas of active remediation. Using an SC remedy located at the Landfill toe will not be effective because it relies upon migration of the COCs from the hotpot area to the toe. Given that the concentrations are relatively high in this area nearly thirty years after closure of the Landfill, it is not likely that they will migrate to the SC remedy at the toe in a reasonable period of time.

New information regarding arsenic impacts on sediment in the perimeter ditch at the toe of the Landfill is consistent with historical conditions. Closure of the ditch and management of impacted sediment will be implemented as proposed in the 2004 AROD because concentrations at 7 of 11 locations tested in the most recent evaluation exceed the sediment ICL for arsenic of 50 mg/Kg.

3.0 SITE-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND REMEDIAL ACTION OBJECTIVES

3.1 GENERAL

Section 3.0 of the 2004 RFFS (pages 3-1 through 3-23, reviewed ARARs and RAOs pertinent to the identification, screening, and selection of remedial alternatives for the Site. It also described:

- the nature of compliance requirements in Section 3.0 (pages 3-1 to 3-2);
- the role of ARARs in the process of evaluating remedial alternatives and carrying out remedial actions in Section 3.0 (page 3-1);
- definitions of the types of ARARs (i.e., applicable, relevant and appropriate, and to-be-considered) in Section 3.1 (page 3-2); and
- classification of ARARs (i.e., chemical-specific, action-specific, and location-specific) in Section 3.2 (pages 3-2 through 3-3).

3.2 IDENTIFICATION AND CONSIDERATION OF ARARS

Section 3.3 of the 2004 RFFS (page 3-3), described the identification and consideration of ARARs relative to identified environmental impacts at the Site and potential remedial activities. Further, more detailed discussion of the origins, relevance, and rationale for selection of action-specific, chemical-specific, and location-specific ARARs were presented in Sections 3.4 (pages 3-3 through 3-7), 3.5 (pages 3-7 through 3-9), and 3.6 (pages 3-9 through 3-10) of the 2004 RFFS, respectively.

In this section of the SC-FFS, ARARs specific to SC are identified for use in evaluating proposed changes in the SC element of the Site remedy. This section is focused on reproducing the ARAR tables presented in the 2004 AROD excluding ARARs that are not relevant to SC.

For this purpose, relatively few changes were made to the ARARs tables, including the following.

- Reference to the draft USEPA vapor intrusion guidance was removed from Table 3-1A because it is not an ARAR for the SC remedies.
- Reference to NOAA Technical Memorandum NOS OMA 52 was removed from Table 3-1B because sediment ecological risk assessment is not an element of the SC remedies (the perimeter ditch is to be closed, removing this wildlife exposure pathway).
- Reference to the State Wellhead Protection Program was removed from Table 3-1C because it is not an ARAR for the SC remedies.

3.3 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

The content, role, and development of RAOs were described in Section H of the 2004 AROD (pages 38 through 41) This discussion is not repeated here; rather, the RAOs relevant to SC are summarized to provide context for evaluation of the proposed SC remedy changes.

3.3.1 Solid Waste

The RAOs presented in the 2004 AROD for solid waste included:

(a) facilitating the treatment of COCs in the solid waste and their transport to ground water and subsequent destruction or immobilization;

(b) preventing direct contact with and ingestion of COC-impacted solid waste materials present in the Landfill;

(c) evaluating appropriate remedial measures for identified sources in the Landfill that may not be adequately addressed by the SC component of the remedial option; and

(d) complying with federal and State ARARs.

3.3.2 Sediments – On-Site

The 2004 AROD RAOs for on-site sediments included:

(a) eliminating or minimizing the potential human exposure to, and environmental impact from, contaminated sediments located in the Landfill perimeter ditch and at the outlet of the ditch to the drainage swale to the Cocheco River;

(b) eliminating or minimizing the migration of contaminated sediments from the perimeter ditch to the Cocheco River by containing or removing contaminated sediments in a manner protective of human health and the environment; and

(c) complying with federal and State ARARs.

3.3.3 Ground Water / Surface Water / Leachate - On-Site

The 2004 AROD RAOs for on-site ground water, leachate, and surface water included:

(a) controlling or containing generation and migration of leachate and impacted ground water that serves as a source of off-site ground water and potential surface water contamination and impact to the perimeter ditch;

(b) reducing the total mass of COCs present in ground water and leachate exiting the Landfill perimeter by collecting and treating or treating *in situ* impacted ground water and leachate to MCLs or levels protective of human health and the environment; and

(c) complying with federal and State ARARs.

3.3.4 Air

The potential exists for the Landfill itself to pose some risk due to VOC off-gassing or fugitive dust emissions. The USEPA concluded in 1991 that the carcinogenic and non-carcinogenic risks for ambient air were within the USEPA's target risk range. This finding was validated by Golder in the 1995 PDI report, which also concluded that methane and gas production from the Landfill likely peaked within five to ten years of its closure in 1978. Given the time elapsed since Golder's 1995 assessment, it is likely that methane and landfill gas production have declined further. Nevertheless, RAOs for air are warranted because of the presence of relatively high VOC concentrations in ground water in the northwest portion of the Landfill warranting remedial action. The 2004 AROD air RAOs included:

(a) eliminating or minimizing risk to human health due to off-gassing of VOCs contained in the surface water currently flowing through the Landfill perimeter ditch;

(b) eliminating fugitive dust emissions from the Landfill;

(c) eliminating or minimizing the risk to human health from migration of VOC vapors from the ground water into the basements of existing homes; and

(d) complying with federal and State ARARs.

Table 3-1A. Action-Specific Potential ARARs

Requirement	Authority	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
FEDERAL - 40 Code of Federal Regulations (CFR) Part 261 RCRA Standards for identification and listing of hazardous waste	Federal Regulatory Requirement	RAR	New Hampshire has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. The relevant and appropriate provisions of the federal regulations have been adopted by the State.	Excavated soils will be analyzed by appropriate test methods. If found to be hazardous wastes, then they will be managed in accordance with the substantive requirements of the State hazardous waste regulations.
FEDERAL - 40 CFR Part 262 RCRA Standards Applicable to Generators of Hazardous Wastes	Federal Regulatory Requirement	RAR	New Hampshire has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. The relevant and appropriate provisions of the federal regulation have been adopted by the State.	If excavated materials are determined to be hazardous wastes, then they will be managed in accordance with the substantive requirements of the State hazardous waste regulations.
FEDERAL - 40 CFR Part 264 RCRA Standards for Owners and Operators of Hazardous Waste TSDF Facilities	Federal Regulatory Requirement	RAR	New Hampshire has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. The relevant and appropriate provisions of 40 CFR Part 264 are incorporated by reference.	Excavated materials that are determined to be hazardous waste will be temporarily stockpiled on-site in accordance with the substantive requirements of the State hazardous waste storage regulations.
FEDERAL - 40 CFR Part 264 Subpart AA RCRA - Air Emission Standards for Process Vents	Federal Regulatory Requirement	AR	Establishes air emission standards for process vents, closed-vent systems, and control devices at hazardous waste facilities; and apply to distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam stripping operations that "manage hazardous wastes with organic concentrations of at least 10 ppmv."[1]	If process vents are used in remedial action, air emission controls will be implemented if the applicability threshold is met.
FEDERAL - 40 CFR Part 264 Subpart BB RCRA - Air Emission Standards for Equipment Leaks	Federal Regulatory Requirement	AR	Establishes air emission standards for equipment leaks at hazardous waste facilities where equipment "contains or contacts hazardous wastes with organic concentrations of at least 10 percent by weight."[1]	If equipment covered by this standard is used in the remedial action and handles hazardous substance at concentrations that meet this rule's threshold, then air emission controls will be implemented.

[1]Because New Hampshire has not yet adopted regulations incorporating 40 CFR 264, subparts AA - CC, the Federal regulations are the source for these ARARs.

Table 3-1A. Action-Specific Potential ARARs

Requirement	Authority	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
FEDERAL - 40 CFR Part 265 Subpart CC RCRA - Air Emission Standards for Tanks, Surface Impoundments and Containers	Federal Regulatory Requirement	AR	Establishes air emission standards for facilities that treat, store or dispose of hazardous wastes in tanks, surface impoundments, or containers.[1]	If tanks, containers, or surface impoundments are used in the remedial action and meet the applicability threshold, then air emission controls will be implemented
STATE - Env-Wm 403.6 Identification and Listing of Hazardous Wastes; Toxicity Characteristic	State Regulatory Requirement	AR	These requirements identify the maximum concentrations of contaminants for which the waste would be a RCRA characteristic waste because of its toxicity. The analytical test set out in Appendix II of 40 CFR Part 261 is referred to as the Toxicity Characteristic Leaching Procedure (TCLP).	Excavated materials from the Site will be analyzed to determine whether they are characteristic hazardous waste under RCRA. Materials that exceed TCLP hazardous waste thresholds will be disposed off-site in a RCRA Subtitle C TSDF. Non-hazardous materials will be used as backfill or disposed appropriately.
STATE - Env-Wm 500 Requirements for Hazardous Waste Generators [formerly He-P Ch. 1905.06]	State Regulatory Requirement	AR	Requires determination as to whether waste materials are hazardous and, if so, requirements for managing such materials on site prior to shipment off site.	If remedial treatment or excavation generates hazardous waste that must be shipped off-site, then it will be managed on-site in accordance with the substantive provisions of these regulations prior to off-site shipment.
STATE - Env-Wm 700 Requirements for Owners and Operators of Hazardous Waste Facilities /Hazardous Waste Transfer Facilities [formerly He-P Ch. 1905.08]	State Regulatory Requirement	RAR	Establishes requirements for owners or operators of hazardous waste sites or treatment facilities (federal requirements 40 CFR Parts 264 are incorporated by reference).	The specific portions of these regulations that are relevant to the remedial alternative(s) to be implemented at the Dover Landfill will be identified and addressed.
STATE - Env-Wm 702.10 – 702.12 Monitoring [formerly He-P Ch. 1905.08(d)(6)a,b]	State Regulatory Requirement	RAR	Establishes requirements for installation and operation of ground water monitoring network capable of detecting potential migration of hazardous waste or constituents. Relevant and appropriate for COCs in ground water.	Selected remedial alternative will include ground water monitoring systems to meet substantive elements of this relevant and appropriate requirement.

Table 3-1A. Action-Specific Potential ARARs

Requirement	Authority	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
STATE - Env-Wm 708.2(k) Closure and Post-Closure Disposal Units	State Regulatory Requirement	RAR	Incorporates by reference 40 CFR 264.110 - .120 (subpart G). Landfill must be closed in a manner that controls, minimizes, or eliminates the potential for land filled COCs to threaten human health and the environment. Closure design must also minimize maintenance of the Site. After the Landfill is closed, regular monitoring and maintenance must be performed for at least 30 years.	SC remedy will comply with the substantive requirements of these regulations.
STATE - Env-Wm 708.3 (d)(1) Use and Management of Containers	State Regulatory Requirement	AR	Establishes requirements for the condition of containers, compatibility of hazardous waste stored in containers, and the management, inspection, and closure of containers. Incorporates by reference 40 CFR 264.170-.179 (Subpart I).	If excavated materials or any other materials generated from the remedy are hazardous waste and are managed in containers, then the containers will be managed to meet the substantive portion of this requirement.
STATE - Env-Wm 708.3(d)(2) Tanks	State Regulatory Requirement	AR	Tanks or tank systems used to temporarily store hazardous liquids or as part of a treatment system for hazardous liquids or sludges must be designed, installed, and operated in accordance with the RCRA Standards. Incorporates by reference 40 CFR 264.140 - .198 (subpart J).	If a tank or tank system is used for storing or treating hazardous wastes as part of Site remediation, it must be constructed with secondary containment and a leak detection system, and comply with monitoring and inspection requirements.
STATE – Env-Wm 708.3(d)(4) Waste Piles [formerly He-P Ch. 1905.08(f)(l)(d)]	State Regulatory Requirement	AR	General design and operation requirements for temporary storage of hazardous soils and/or sludges. Locations must have an impermeable liner and materials stored in piles must be free of standing liquid. Incorporates by reference 264.250-259 (subpart L).	If hazardous waste piles are included in the remedial alternative selected for the Landfill, then these requirements must be met.

Table 3-1A. Action-Specific Potential ARARs

Requirement	Authority	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
STATE - Env-Wm 1403 Groundwater Management and Ground Waste Release Detection Permits	State Regulatory Requirement	AR	Prohibits discharge of hazardous waste to ground water, or any discharge to ground water that would result in a violation of surface water quality in adjacent surface waters. Also, ground water cannot be altered so as to make it unsuitable for drinking.	Ground water monitoring and treatment will be required to attain State AGQSs. Any ground water discharges from treatment systems, including the treatment trench, must meet the applicable standards. A GMZ would remain in place in the Eastern and Southern Plumes at the Site and until the ground water cleanup goals have been attained.
STATE – RSA 485-A:17 and NH Admin. Code Env-Ws 415 Terrain Alteration	State Regulatory Requirement	AR	Establishes criteria to control erosion and run-off for any activity that significantly alters the terrain.	Any action taken at the Site that will disturb an area of more than 100,000 contiguous square feet must comply with these criteria.
STATE – NH Admin. Code Env-A Part 1002 Fugitive Dust Control	State Regulatory Requirement	AR	Requires precautions to prevent, abate, and control fugitive dust during specified activities, including excavation, construction, and bulk hauling.	Precautions to control fugitive dust emissions will be required both during and after Site remediation.
STATE - Env-Ws 1500 New Hampshire Ground Water Discharge Permit and Registration Rules	State Regulatory Requirement	AR	These regulations established substantive requirements for discharges to ground water, including prohibited discharges (Env-Ws 1503.04), compliance criteria (Env-Ws 1504.03), water quality sampling (Env-Ws 1507.01).	If water is discharged into the Landfill or to ground water, then such discharges will receive appropriate treatment to comply with the substantive requirements of this ARAR.

Table 3-1A. Action-Specific Potential ARARs

Requirement	Authority	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
STATE - Env-A300 Ambient Air Quality Standards	State Regulatory Requirement	AR	Establishes primary and secondary level for eight air contaminants: • particulate matter • sulfur dioxide • carbon dioxide • nitrogen dioxide • ozone • hydrocarbons • fluorides • lead Seven of the primary and secondary standards established under this State standard are adopted from the federal National Ambient Air Quality Standards (NAAQS).	These air contaminant levels will be used to establish target levels for air releases from the Site.
STATE - Env-A 1300 Toxic Air Pollutants	State Regulatory Requirement	AR	Establishes ambient air limits for 74 chemicals. These ambient air limits (AALs) are levels at, or below, which ambient air concentrations of respective air contaminant will not adversely affect human health.	Releases of contaminants to the air from any source on-site will not exceed applicable AALs.

Table 3-1B. Chemical-Specific Potential ARARs

Media	Requirement	Authority	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Ground Water	STATE – Env–Ws 1400 Ground Water Protection Standards	State Regulatory Requirement	AR	New Hampshire AGQSs are based upon New Hampshire Division of Public Health Services health-based standards that apply to all ground water in the State, consistent with the Legislature's designation of all ground water as a potential water supply. Ground water non-degradation requirements incorporate the surface water quality standards at Env–Ws 1700.	New Hampshire AGQSs will be used to set cleanup levels for COCs in ground water. SWQSs should also be considered in establishing ground water cleanup levels.
Ground Water	Safe Drinking Water Act (SDWA) - MCLs (40 CFR 141.11-141.14). Revised MCLs (40 CFR 141.61-141.62) and non-zero MCLGs (40 CFR 141.50-141.51)	Federal Regulatory Requirement	RAR (MCLs); TBC (MCLGs)	MCLs have been promulgated for a number of common organic and inorganic contaminants to regulate the concentration of contaminants in public drinking water supply systems. MCLs are relevant and appropriate for Site ground water because ground water in the Site vicinity may be used for drinking water. MCLGs are non-enforceable health goals for public water systems.	Ground water at the point of compliance will attain State AGQSs at the completion of the remedy. State AGQSs preempt federal MCLs/MCLGs because they are specific standards established for State ground water. If a State AGQS is not established for a given constituent or is higher, the federal MCL/MCLG will be relevant and appropriate requirement (RAR)/to be considered (TBC).
Ground Water	New Hampshire Drinking Water Quality Standards (Env-Ws 316, 317, 319)	State Regulatory Requirement	RAR (MCLs); TBC (MCLGs)	State MCLs and MCLGs establish maximum contaminant levels permitted in public water supplies and are the basis of State AGQSs that are applicable to Site ground water. Secondary MCLs apply to contaminants that primarily affect the aesthetic quality of drinking water. The regulations are generally equivalent to the Federal SDWA. State drinking water quality standards are relevant and appropriate for Site ground water because ground water in the Site vicinity may be used for drinking water.	Ground water at the point of compliance will attain State AGQSs at completion of the remedy. AGQSs are the same as these standards.
Ground Water Surface Water	FEDERAL – USEPA Risk (RfDs)	Federal Regulatory Requirement	TBC	RfDs are dose levels developed by the USEPA for non-carcinogenic effects.	USEPA RfDs will be used to characterize risks due to exposure to COCs in ground water and other media.

Table 3-1B. Chemical-Specific Potential ARARs

Media	Requirement	Authority	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Ground Water Surface Water	FEDERAL – USEPA Carcinogen Group Potency Factors	Federal Regulatory Requirement	TBC	Potency Factors are developed by the USEPA from Health Assessments or evaluation by the Carcinogen Effects Assessments Group.	USEPA Carcinogenic Potency Factors will be used to compute the individual incremental cancer risk resulting from exposure to Site COCs.

Table 3-1C. Location-Specific Potential ARARs

Media	Requirement	Authority	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Wetlands	FEDERAL -- Clean Water Act (CWA) Section 404; 40 CFR Part 230:33 CFR Parts 320-330	Federal Regulatory Requirement	AR	These codes establish requirements for the discharge of dredged or fill material into water bodies or wetlands. The regulations prohibit the discharge of dredged or fill material "if there is a practicable alternative…which would issue less impact on the aquatic ecosystem."	Remedial actions that will result in filling of water bodies or wetlands around the Site must comply with the substantive portions of these requirements. Filling the perimeter ditch is the least environmentally damaging, practicable solution because it will minimize contact with contaminated sediments, prevent sediment re-contamination, and allow ground water to migrate to collection or treatment systems for permanent treatment.
Wetlands	Federal Executive Orders 11990 Protection of Wetlands FEDERAL – 40 CFR Part 6 Appendix A	Federal Regulatory Requirement	AR	Federal agencies are required to avoid the destruction or modification of wetlands, and direct or indirect support of new construction in wetlands wherever there is a practicable alternative. Where avoidance of wetlands cannot be achieved, the proposed action includes all practicable means to limit impact to wetlands that may result from such activity.	Remedial actions will use practicable means to avoid destruction or modification of wetlands surrounding the Site.
Land	FEDERAL – RCRA General Facility Standards 40 CFR 264.18(a) Seismic Standards	Federal Regulatory Requirement	RAR	Construction of new hazardous waste treatment, storage, or disposal facilities is prohibited within 200 feet of a fault that has had a displacement in Holocene time.	Construction of an on-site treatment facility, if used, will consider this location standard in design.
Wetlands	FEDERAL – 16 USC 661 et. seq., Fish and Wildlife Coordination Act	Federal Regulatory Requirement	AR	Requires actions to be taken to avoid adverse effects, minimize potential harm to fish or wildlife, and preserve natural and beneficial uses of the land.	Relevant federal agencies must be contacted to help analyze impacts of remedial action on wildlife in wetlands.
Wetlands	STATE – RSA 482-A and Env-Wt 300 - 400, 600, New Hampshire Criteria and Conditions for Fill and Dredging in Wetlands	State Regulatory Requirement	AR	Any activity in or adjacent to wetlands, including filling and dredging, must meet these criteria for wetlands protection.	Remedial activities that affect the wetlands will meet the substantive requirements of this State statute and its regulations.

4.0 GENERAL RESPONSE ACTIONS AND ALTERNATIVE DEVELOPMENT

4.1 GENERAL

The RAOs described in Section 3.3 served as the basis for comparison of the SC remedial alternatives in this SC-FFS. This section does not develop alternatives through the typical FS technology screening and combination process; rather, it describes the three SC alternatives to be evaluated. For this SC-FFS, the MOM component of each remedial alternative is not represented or discussed herein. In contrast to the 2004 RFFS, this section was modified based upon the new information obtained by performing the PDIs.

The three alternatives considered include the following:

- the SC elements of the No Action Alternative described in the 2004 AROD, as required by the National Contingency Plan (NCP);
- the SC-A alternative described in the 2004 AROD that uses the Landfill and ground water beneath it as a bioreactor and an air sparging and aerobic treatment trench installed at the toe of the Landfill (described in Section 4.5 of this SC-FFS); and
- an alternative SC remedy, identified as SC-Ex, that uses the Landfill and ground water beneath as a bioreactor, and extraction of leachate and ground water at the toe of the Landfill for off-site treatment at the Dover POTW (described in Section 4.6 of this SC-FFS).

4.2 METHODOLOGY

The No Action Alternative (SC-1) was described and discussed in detail in Section 4.3 of the 2004 RFFS (pages 4-8 through 4-10). Accordingly, although Superfund FS practice typically is to compare remedial alternatives to the No Action Alternative, this SC-FFS focuses on detailed evaluations of the SC elements of the 2004 AROD Remedy (SC-A) and the alternative (SC-Ex). Both are compared to the No Action Alternative in Section 5.7 of this SC-FFS; however, it is documented in the 2004 AROD that the No Action Alternative is not acceptable for this Site.

As discussed in Section 1.3, the Group reviewed an alternative SC approach employing ground water extraction and off-site treatment that could offer a more cost-effective, permanent treatment of the target COCs at the Site than the SC-A remedy identified in the 2004 AROD. Based upon discussions with the USEPA and NHDES, it was agreed that this SC-FFS would include an evaluation of the Landfill bioreactor/aerobic treatment trench SC remedy (SC-A) compared to the Landfill bioreactor/extraction/off-site treatment SC remedy (SC-Ex). This alternative remedy concept for SC was developed while considering the potential exposure pathways and associated risks within the Landfill footprint and at its downgradient perimeter and the general response actions relative to the RAOs. It is important to note the SC-Ex remedy is conceptually the same as the 100 percent design of the 1991 ROD remedy, revised slightly to accommodate new information regarding Site conditions, use of a permeable Landfill cap, and updated model simulations of ground water flow.

4.3 GENERAL RESPONSE ACTIONS

General response actions developed for the RAOs identified in Section 3.3 are described in this section in tabular form. Response actions for the three SC remedial alternatives are listed for each RAO.

Solid Waste

RAO	General Response Action	
(a) Facilitate the treatment of COCs in the solid waste and their transport to ground water and subsequent destruction or immobilization. (b) Prevent direct contact with and ingestion of COC-impacted solid waste materials present in the Landfill. (c) Evaluate appropriate remedial measures for identified sources in the Landfill that may not be adequately addressed by the SC component of the remedial option. (d) Comply with federal and State ARARs.	No Action Alternative	• Monitoring Note: Access restrictions in the form of fencing and warning signs will mitigate potential risks associated with a No Action Alternative for solid waste at this Site.
	SC-A	• Augment/maintain existing permeable soil Landfill cap • Evaluate appropriate remedial measures for identified sources in the Landfill that may not be adequately addressed by the SC component of the remedial option or may be more efficiently addressed locally • Access restriction (fencing, warning signs) • Monitoring
	SC-Ex	• Augment/maintain existing permeable soil Landfill cap • Evaluate appropriate remedial measures for identified sources in the Landfill that may not be adequately addressed by the SC component of the remedial option or may be more efficiently addressed locally • Access restriction (fencing, warning signs) • Monitoring

Sediments - On-Site

RAO	General Response Action	
(a) Eliminate or minimize the potential human exposure to, and environmental impact from, contaminated sediments located in the Landfill perimeter ditch and at the outlet of the ditch to the drainage swale to the Cocheco River. (b) Eliminate or minimize the migration of contaminated sediments from the perimeter ditch to the Cocheco River. Contain or remove contaminated sediments in a manner protective of human health and the environment. (c) Comply with federal and State ARARs.	No Action Alternative	• Monitoring Note: The existence of access restrictions in the form of fencing and warning signs will mitigate potential risks associated with a No Action Alternative for impacted sediment at this site.
	SC-A	• Removal and off-site disposal of contaminated sediments from the ditch and swale. • Backfill perimeter ditch • Access restriction (fencing, warning signs) • Monitoring
	SC-Ex	• Removal and off-site disposal of contaminated sediments from the ditch and swale. • Backfill perimeter ditch • Access restriction (fencing, warning signs) • Monitoring

Ground Water / Surface Water / Leachate - On-Site

RAO	General Response Action	
(a) Control or contain generation and migration of leachate and impacted ground water that serves as a source of off-site ground water and potential surface water contamination and impact to the perimeter ditch. (b) Reduce the total mass of COCs present in ground water and leachate. Treat or naturally attenuate ground water and leachate to MCLs or levels protective of human health and the environment. (c) Comply with federal and State ARARs. (Note: Ground water fate and transport modeling results indicate that arsenic is likely to persist in ground water at concentrations above ICLs/AGQSs for 100 years or more regardless of remedy.)	No Action Alternative	• Monitoring
	SC-A	• Interception and *in situ* treatment in flow-through air sparging trench at downgradient Landfill toe • Extraction and *ex situ* treatment (discharge back into Landfill bioreactor) THF-impacted ground water at southwest corner of Landfill • Vertical flow diversion barrier at northeast corner of Landfill (along Tolend Road) to enhance ground water and leachate capture • Monitoring of capture and treatment effectiveness
	SC-Ex	• Interception and capture of ground water and leachate by extraction from wells at Landfill toe • Off-site permanent treatment of collected leachate / ground water at Dover POTW • Monitoring of capture effectiveness

Air

RAO	General Response Action	
(a) Eliminate or minimize risk to human health due to off-gassing of VOCs contained in the surface water currently flowing through the Landfill perimeter ditch. (b) Eliminate fugitive dust emissions from the Landfill. (c) Comply with federal and State ARARs.	No Action Alternative	• Monitoring
	SC-A	• Backfill perimeter ditch and augment existing soil cover and vegetation on Landfill cover to prevent fugitive dust emissions • Intercept ground water and leachate for *in situ* treatment in trench at Landfill toe • Monitoring
	SC-Ex	• Backfill perimeter ditch and augment existing vegetation on Landfill cover to prevent fugitive dust emissions • Intercept ground water and leachate for off-site treatment using extraction wells at Landfill toe • Monitoring

4.4 NO ACTION ALTERNATIVE (SC-1)

The No Action Alternative includes SC (SC-1) as described in Section 4.3 of the 2004 RFFS (pages 4-8 through 4-10). In addition, institutional and access controls and other actions performed at the Site that provide additional mitigation of risk for No Action are identified, where applicable. This alternative was evaluated using the criteria in Section 5.4 (pages 5-5 through 5.10) of the 2004 RFFS.

The No Action Alternative does not include active remediation efforts except for long-term monitoring of ground water, surface water, sediment, and landfill gas. For this alternative, natural attenuation processes will be relied upon to eliminate the source of COCs in the solid waste material, treat COCs in leachate and ground water beneath the Landfill, and mitigate impacts to surface water, sediment, and ground water. These media will be monitored regularly for an indefinite period until compliance with ARARs is attained or until decided otherwise during the five-year Superfund Amendments and Reauthorization Act (SARA) review process. A more detailed discussion of natural attenuation processes in general and evidence of its occurrence at the Site is presented on pages 4-8 through 4-9 of the 2004 RFFS (Section 4.3).

4.5 SC-A

The SC-A remedy was described in Section K.1 of the 2004 AROD. The SC-A remedy is evaluated using the nine criteria in Section 5.5.

The SC-A remedy involves:

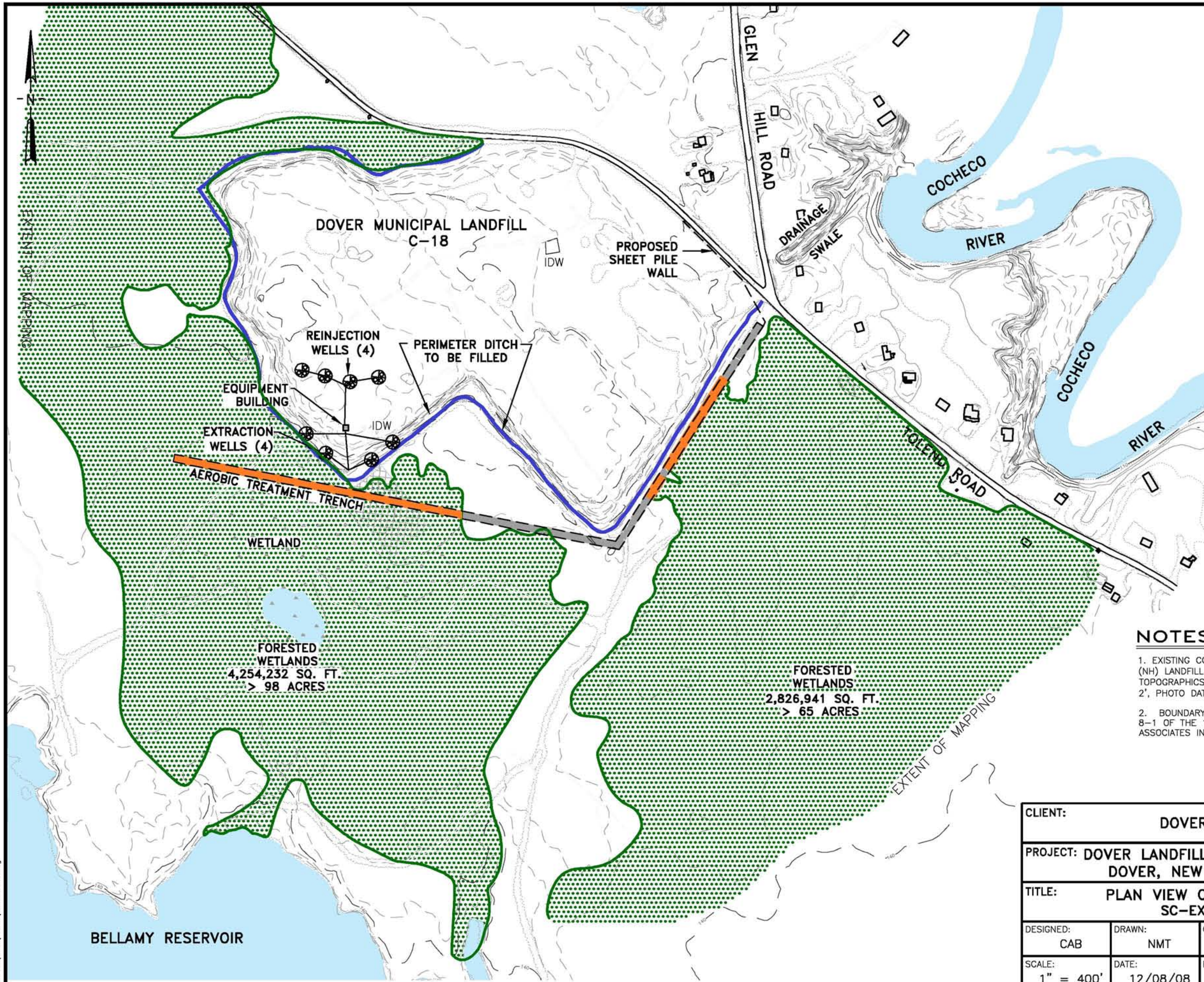
- augmentation and maintenance of the permeable, vegetated, protective cover currently on the Landfill;
- evaluation of the appropriateness of the Landfill cover at the conclusion of the ground water remedy;

- closure of the perimeter ditch by backfilling;
- removal of sediments impacted by arsenic above 50 mg/Kg from the perimeter ditch and drainage swale;
- construction and operation of an aerobic treatment trench along the southern and southeastern boundary of the Landfill;
- construction of a vertical hydraulic barrier to direct ground water flow to the treatment trench near the northeast corner of the Landfill (along Tolend Road);
- construction of a ground water extraction and *ex situ* treatment system near the southwest corner of the Landfill to treat and manage THF-impacted ground water; and
- evaluation of appropriate remedial measures for identified source areas in the Landfill that may not be adequately treated by the SC component.

The conceptual SC-A remedy is illustrated in Figure 4-1.

A key component to the long-term effectiveness of the SC-A remedy is the overall reduction of COC mass resulting from biodegradation occurring within the solid waste mass and general limits of the Landfill. Continued infiltration of water into the Landfill mass will be required to sustain the microbial populations responsible for continued degradation within the Landfill (this mechanism is discussed in more detail on page 4-22 of the 2004 RFFS) and to maintain a hydraulic gradient that will flush residually-impacted ground water to the SC treatment system at an optimal rate. The Landfill is currently covered with a permeable, vegetated soil cover. The design of the SC-A remedy requires that the cover remain permeable to be effective.

The existing permeable and vegetated soil cover on the Landfill will be maintained to ensure that direct contact with waste will not occur while maintaining continued infiltration of water necessary for biodegradation activity in the Landfill. The existing vegetation on top of the Landfill will not be disturbed, and areas of exposed waste, if present, will be covered with additional soil to prevent direct contact with solid wastes and promote vegetative growth.



LEGEND

IDW	INVESTIGATION DERIVED WASTE STORAGE AREA
(well symbol)	PROPOSED GROUND WATER EXTRACTION WELL CLUSTER LOCATIONS (17 PROPOSED)
(orange)	TEMPORARY WETLANDS IMPACTS (APPROXIMATE LENGTH – 1,700 FEET X 30' WIDE, 1.2 ACRES)
(blue)	PERMANENT CLOSING OF PERIMETER DITCH (APPROXIMATE LENGTH – 5,220 FEET X 10' WIDE, 1.2 ACRES)
(green dotted)	FORESTED WETLAND COMPLEX (163 ACRES)
(grey dashed)	PROPOSED AEROBIC TREATMENT TRENCH (APPROXIMATE LENGTH – 2,900 FEET X 30' WIDE, 2.0 ACRES)

DRAFT

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.

2. BOUNDARY OF FORESTED WETLANDS COMPLEX WAS BASED UPON FIGURE 8-1 OF THE 1995 PRE-DESIGN INVESTIGATION, PREPARED BY NORMANDEAU ASSOCIATES INC.

0 400 800
APPROX. SCALE IN FEET

CLIENT: DOVER GROUP				GeoInsight Practical in Nature
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE				
TITLE: PLAN VIEW OF CONCEPTUAL SC-EX REMEDY				
DESIGNED: CAB	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW	
SCALE: 1" = 400'	DATE: 12/08/08	FILE NO.: 2009D255	PROJECT NO.: 2009-007	FIGURE NO.: 4–1

PLOT DATE: 2-19-09
FILE: C:\GEO\2009\2009d255.dwg

The current condition of the existing cover was described in more detail on page 4-24 of the 2004 RFFS (photographs were included in Appendix A of that RFFS).

The perimeter ditch surrounding the Landfill will be backfilled to eliminate exposure risks associated with impacted sediments and to ensure that shallow ground water that may be seasonally intercepted by the perimeter ditch (and transported to the drainage swale) is treated in the aerobic treatment trench. In addition, hotspots of arsenic in sediment in the perimeter ditch and the drainage swale that exceed the ICL will be removed and disposed of off-site.

An aerobic treatment trench will be installed to intercept and treat COC-impacted ground water and leachate migrating from beneath the Landfill. The aerobic trench will extend from the southwest corner of the Landfill (in the vicinity of well cluster SC-11) to the northeast corner of the Landfill near the intersection of Glen Hill Road and Tolend Road as illustrated in Figure 4-1. The treatment trench will be approximately 2,900 feet long and between 3 to 5 feet wide.

COCs intercepted by the trench will be treated by a combination of volatilization and aerobic biodegradation for organic COCs and precipitation and/or sorption for arsenic. Compounds that are not completely volatilized from the ground water, such as THF, will be rapidly degraded by aerobic microorganisms growing in the aerated ground water within the engineered backfill in the treatment trench. An evaluation of the capacity of the trench to treat organic COCs was included in Appendix J of the 2004 RFFS (pages 3 through 6).

Arsenic is expected to co-precipitate with iron oxyhydroxides and sorb onto iron oxyhydroxide surfaces within the treatment trench under oxidizing conditions created by injection of air into the backfill. As arsenic-containing mineral precipitates form within the treatment trench, the precipitates will accumulate within the treatment trench, potentially reducing the trench backfill material's effective hydraulic conductivity. More detailed discussion of the mechanisms and kinetics of arsenic removal/immobilization through the precipitation/sorption reactions were discussed in Appendix K-5 of the 2004 RFFS (pages 1 through 5). Issues related to potential clogging of the treatment trench with precipitates and contingency measures to address these issues were discussed in more detail in Section 4.5 of the 2004 RFFS (pages 4-29 through 4-32) and supported by information and analyses presented in Appendices K-1 and K-6 of that document. Contingency measures evaluated included stabilization of arsenic upgradient of the trench by injecting sulfate, cleaning the trench backfill by re-circulating and collecting an acidic solution, or removing and replacing clogged backfill media.

The main considerations in design of the aerobic treatment trench system will be to ensure that:

- impacted ground water will flow through, not around or beneath, the aerobic treatment trench;
- target compounds can be removed to cleanup levels through a combination of volatilization, biodegradation, or precipitation/sorption processes;
- the air injection manifold provides a relatively uniform fluid flow (i.e., promotes diffused gas flow and minimizes channeling) over the length of the treatment system segments;
- management of precipitates collected in the trench backfill and related clogging issues; and
- piezometers and monitoring wells are properly placed to obtain representative samples.

The system design will be based upon well-understood principles of multi-fluid phase flow, geochemistry, mass transfer, and biodegradation kinetics. Design, construction, and operation of the aerobic treatment trench system was described in more detail in Section 4.5 (pages 4-25 through 4-27) and Appendices L-1 and K-1 of the 2004 RFFS.

A vertical hydraulic barrier, likely consisting of a sheet pile wall, will be constructed along Tolend Road at the northeast corner of the Landfill to manage ground water flow in that area. The hydraulic barrier will ensure southeasterly flow of ground water through the treatment trench in this area of the Site. The hydraulic barrier will extend approximately 1,300 feet from the intersection of the treatment trench with Tolend Road toward the north and west along the south side of Tolend Road. The hydraulic analyses supporting conceptual design of this barrier were described in the 2004 RFFS (Appendix N, pages 4-23 through 4-29).

Elevated concentrations of THF (compared to the rest of the Site) are present in ground water in the western lobe of the Landfill extending to the southwest corner of the Landfill between SC-10 and MW-101 well clusters (the most recently filled portion of the Landfill). Based upon current data, the aerobic treatment trench may not be able to reduce these concentrations to meet cleanup criteria (Appendix J of 2004 RFFS, pages 5 through 6). The SC-A remedy, therefore, includes an *ex situ* treatment system suitable for treating THF-impacted ground water and leachate collected upgradient of the trench at the southwest corner of the Landfill. After treatment to meet re-injection standards for COCs, the ground water will be re-injected into the Landfill (per the USEPA letter dated October 10, 2003 in Appendix O of the 2004 RFFS).

Periodic monitoring will be used to evaluate the performance of the treatment trench. Piezometers will be used to evaluate hydraulic conditions upgradient, within, and downgradient of the treatment trench. Monitoring wells upgradient of the treatment trench will be used to measure COC concentrations leaving the Landfill and entering the treatment trench. Monitoring wells within and downgradient of the treatment trench will be used to demonstrate compliance with remedy performance requirements. In addition, Landfill gas migration monitoring will be performed at the Landfill perimeter.

4.6 ALTERNATIVE EXTRACTION REMEDY (SC-EX)

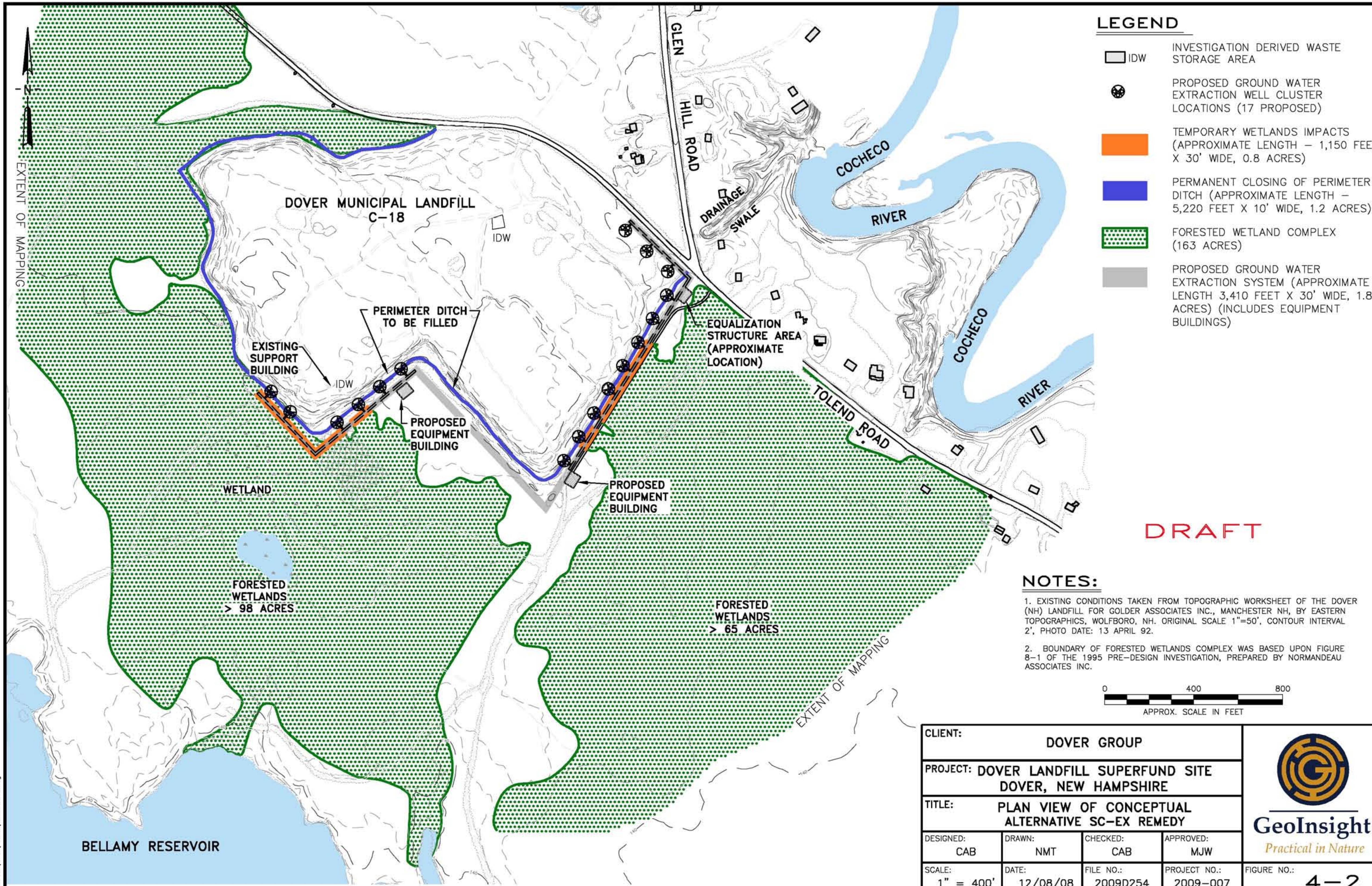
In alternative SC-Ex, extracted ground water will be transferred to the Dover POTW for treatment. This approach differs from SC-A in the manner in which impacted ground water and leachate is intercepted and treated; in all other respects the two SC remedies are alike with the exception that SC-Ex does not require design, construction, and operation of a separate extraction and *ex situ* treatment system for THF-impacted ground water in the southwestern portion of the Landfill. The SC-Ex remedy is evaluated using the nine criteria in Section 5.6.

The SC-Ex remedy will involve:

- augmentation and maintenance of permeable, vegetate protective cover currently on the Landfill;
- evaluation of the appropriate Landfill cover at the conclusion of active SC operation;
- closure of the perimeter ditch around the Landfill by backfilling;
- ground water and leachate extraction via recovery wells at the toe of the Landfill;
- off-site treatment of extracted ground water and leachate at the Dover POTW;
- removal of sediments impacted by arsenic above 50 mg/Kg from the perimeter ditch and drainage swale; and
- evaluation of appropriate remedial measures for identified source areas in the Landfill that may not be adequately treated by the SC component.

Alternative SC-Ex will include augmentation of the existing Landfill cover to prevent contact with waste material, closure of the perimeter ditch by backfilling, and removal of sediment from the perimeter ditch and drainage swale that contains arsenic at concentrations above 50 mg/kg, all of which are elements of the SC-A SC remedy. The scope and rationale for these SC remedy elements are described in Section 4.5.

Based upon preliminary ground water modeling of potential capture zones (described below), it was estimated that 17 extraction well multiplets will be installed along the downgradient toe of the Landfill as illustrated in Figure 4-2. Extraction wells will be installed using standard well drilling techniques and equipment. The multiplets will be designed to capture and extract leachate and impacted ground water migrating from beneath the Landfill in the US, UUI, and LUI strata. The wells will be constructed with a suitable filter pack around the well screen to limit migration of fine-grained soil particles into the well and will be sealed at



LEGEND

- IDW — INVESTIGATION DERIVED WASTE STORAGE AREA
- PROPOSED GROUND WATER EXTRACTION WELL CLUSTER LOCATIONS (17 PROPOSED)
- TEMPORARY WETLANDS IMPACTS (APPROXIMATE LENGTH – 1,150 FEET X 30' WIDE, 0.8 ACRES)
- PERMANENT CLOSING OF PERIMETER DITCH (APPROXIMATE LENGTH – 5,220 FEET X 10' WIDE, 1.2 ACRES)
- FORESTED WETLAND COMPLEX (163 ACRES)
- PROPOSED GROUND WATER EXTRACTION SYSTEM (APPROXIMATE LENGTH 3,410 FEET X 30' WIDE, 1.8 ACRES) (INCLUDES EQUIPMENT BUILDINGS)

NOTES:

1. EXISTING CONDITIONS TAKEN FROM TOPOGRAPHIC WORKSHEET OF THE DOVER (NH) LANDFILL FOR GOLDER ASSOCIATES INC., MANCHESTER NH, BY EASTERN TOPOGRAPHICS, WOLFBORO, NH. ORIGINAL SCALE 1"=50', CONTOUR INTERVAL 2', PHOTO DATE: 13 APRIL 92.

2. BOUNDARY OF FORESTED WETLANDS COMPLEX WAS BASED UPON FIGURE 8-1 OF THE 1995 PRE-DESIGN INVESTIGATION, PREPARED BY NORMANDEAU ASSOCIATES INC.

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APPROX. SCALE IN FEET

CLIENT: DOVER GROUP				GeoInsight Practical in Nature
PROJECT: DOVER LANDFILL SUPERFUND SITE DOVER, NEW HAMPSHIRE				
TITLE: PLAN VIEW OF CONCEPTUAL ALTERNATIVE SC-EX REMEDY				
DESIGNED: CAB	DRAWN: NMT	CHECKED: CAB	APPROVED: MJW	
SCALE: 1" = 400'	DATE: 12/08/08	FILE NO.: 2009D254	PROJECT NO.: 2009-007	FIGURE NO.: 4-2

PLOT DATE: 2-19-09
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the ground surface to prevent infiltration of surface runoff. The wellheads will be secured to prevent unauthorized tampering and damage due to vandalism.

Submersible pumps with automated high/low switches will be installed in the extraction wells. The discharge piping from the wells will be equipped with flow recording devices to facilitate operational assessments. An evaluation of the time required to reach ICLs within the Landfill for alternative remedies that did not include an impermeable cap was performed for the 2004 RFFS. The evaluation results performed for the alternative remedies are considered applicable to this remedy (SC-Ex) because this remedy includes the same permeable cover, and flushing and attenuation rates will be similar.

The primary consideration in the design of a ground water interception and extraction system is ensuring effective capture of the leachate and impacted ground water plume exiting the Landfill footprint. The system design will be based upon well-understood principles of ground water and extraction well hydraulics and Site-specific information regarding the distribution and concentrations of COCs and characteristics of the aquifer underlying the Site above the Marine Clay. Extensive information is available regarding COC distribution and the characteristics of the aquifer from the long period of monitoring (i.e., more than ten years) and the multiple studies of Site conditions completed since the RI was initiated. Design activities will address physical system parameters (e.g., numbers and locations of wells, well screen slot size and set points, sizing of pumps, sizing of pipe to convey extracted leachate and ground water to the municipal sewer system, etc.) and operating parameters (e.g., well radii of influence, flow rates, etc.). Design criteria will be obtained from pumping tests completed by Golder and SEA in investigations completed in 1995 and 1994, respectively. These data will be used in conjunction with the ground water flow and contaminant transport model developed in conjunction with the 2004 RFFS, as amended to address USEPA and NHDES comments from April 2005, to evaluate the appropriate configuration of the extraction system to ensure capture. This model was used to run the simulations that were the basis for the system layout illustrated in Figure 4-2. Modeling results are included in Appendix D of this SC-FFS.

Preliminary modeling results (Appendix D) indicated that 17 multiplets would be needed to capture ground water at the toe of the Landfill (note: this number and array of multiplets may be changed as the design is developed and finalized). The capture zone extends approximately 500 feet past the boundary of the Landfill toe based upon the model simulations. For preliminary modeling purposes, typical pumping rates for the US unit wells ranged from 4.2 to 8.8 gallons per minute (gpm), and typical pumping rates for the UUI/LUI unit wells ranged from 0.1 to 1.1 gpm. It should be noted that, in the area of the swale, pumping rates in the model are higher than likely achievable because of modeling constraints in this area. Design of the numbers, locations, and pumping rates of wells in this area will have to be carefully evaluated to ensure that necessary capture is accomplished in this area; it is possible that refinement of the model will be necessary to support this effort. The typical simulated pumping rates noted above are consistent with pumping rates achieved during PDI pumping tests performed by Golder and SEA. The combined flow rate for the system was estimated to be 116.5 gpm and 167,803 gallons per day (gpd).

The extracted leachate and ground water will be discharged to the City of Dover municipal sewer system for treatment at the Dover POTW. Golder evaluated the expected characteristics of this discharge in its 1995 PDI report, in which it reported that the Dover POTW operator concluded that the discharge could be adequately treated by the POTW without adverse impacts on its operations. In addition, the Dover POTW operator reported that there was ample capacity for the estimated discharge flow. This analysis was re-visited by representatives of the City of Dover in 2006, and the Dover POTW operator affirmed the conclusions it reached in 1995. It is expected that approximately 6,000 feet of piping and one lift station will be installed to receive the leachate and ground water discharge from the Site and transfer it to the Dover sewer system. Installation of the transfer conveyance piping may involve a river crossing of the Cocheco River at a location north and east of the Site. Final route selection and approach will be coordinated with the City of Dover POTW.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 INTRODUCTION

Three SC remedial action alternatives were addressed in this SC-FFS including:

- the No Action Alternative SC Remedy (SC-1);
- the SC-A SC Remedy; and
- the Alternative SC-Ex SC Remedy.

The three SC remedies were described in Sections 4.4, 4.5, and 4.6, respectively. The primary components of the remedies are identified in Table 5-1. Of the three, the latter two (SC-A and SC-Ex) were evaluated in detail in Sections 5.5 and 5.6, respectively. The No Action Alternative (SC-1) was not evaluated in detail in this SC-FFS because the 2004 AROD found it not protective and conditions at the Site have not changed since that assessment.

Table 5-1 Remedial Alternative Components

COMPONENTS BY MEDIUM	SC-1	SC-A	SC-Ex
Ground Water – On-Site	NO ACTION*		
Interceptor Trench/Collection System		•	
Ground Water Extraction/Collection System			•
On- or Off-Site Treatment System		•	•
Aerobic Treatment Trench		•	
Landfill Anaerobic Bioreactor		•	•
Local Recirculation System		•	
Access Controls		•	•
Monitoring		•	•
Solid Waste			
Permeable Soil Cover / ARAR Compliant Cap		•	•

COMPONENTS BY MEDIUM	SC-1	SC-A	SC-Ex
Sediment			
Fill Perimeter Ditch and Drainage Swale Hotspot Removal		•	•
Monitoring		•	•
Landfill Gas			
Monitoring		•	•

* The No Action Alternative is limited to monitoring of ground water, sediment, surface water, and landfill gas. It should be noted that access and institutional controls currently in place will serve to mitigate risks associated with use of a No Action remedy at the Site.

5.2 EVALUATION CRITERIA

The detailed individual analyses evaluate the two SC remedial alternatives selected for final consideration. These alternatives were evaluated individually and then in comparison to one another against the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) threshold criteria of:

- overall protection of human health and the environment; and
- compliance with ARARs.

They were also evaluated against the five CERCLA balancing criteria including:

- long-term effectiveness and permanence;
- reduction of toxicity, mobility, or volume through treatment;
- short-term effectiveness;
- implementability; and
- cost.

The two CERCLA modifying criteria (State and community acceptance) will be evaluated after State and public comments on the SC-FFS and Proposed Plan are received and evaluated. The purpose of this analysis is to provide sufficient information to compare the alternatives, select an appropriate remedy for the Site, and demonstrate its compliance with the CERCLA requirements.

5.2.1 Overall Protection of Human Health and the Environment

The NCP requires that the selected remedy adequately protect human health and the environment over the long-term. The overall assessment of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. This evaluation criterion describes the manner in which Site risks posed through the identified pathways are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. This evaluation criterion also considers whether the alternative poses any unacceptable short-term or cross-media impacts.

5.2.2 Compliance with ARARs

This criterion is used to evaluate whether an alternative will meet federal and State ARARs. It identifies the requirements that are applicable or relevant and appropriate to an alternative and describes how the alternative meets action-specific, chemical-specific, and location-specific ARARs. If an ARAR is not met, the basis for justifying a waiver will be discussed. (It should be noted that ground water fate and transport modeling results indicate that arsenic is likely to persist in ground water at concentrations above ICLs/AGQSs for 100 years or more regardless of the remedy.) The ARARs identified in Section 3.0 and whether they will be attained for the three remedial scenarios are summarized in Tables 5-2A, 5-2B, and 5-2C located at the end of Section 5.

5.2.3 Long-Term Effectiveness and Permanence

This criterion addresses the risk remaining at the Site after RAOs are met. Specific evaluation of this criterion focuses on assessing the magnitude of the residual risk and the adequacy and reliability of controls used to manage remaining waste and treatment residuals over the long-term.

5.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This criterion addresses the statutory preference for selecting remedial actions that employ treatment to permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances. Specifically, the factors on which this analysis focuses include:

- the treatment processes and what they will treat;
- the amount of hazardous materials treated or destroyed and how the principal threat is addressed;
- the degree of expected reduction in toxicity, mobility, or volume;
- the degree to which treatment will be irreversible; and
- the type and quantity of residuals that will remain following treatment.

5.2.5 Short-Term Effectiveness

This criterion addresses the effects of a remedial alternative during the construction and implementation phase, including the protection of the community and workers, potential environmental impacts and mitigative measures, and the general time frame to achieve cleanup goals.

A three-dimensional hydrogeologic and fate and transport model was developed to estimate cleanup times. In general, the model incorporates hydraulic and geologic data collected at the

Site during prior investigations and monitoring activities. The development and use of the model is described in Appendix N of the 2004 RFFS (GeoInsight, 2004) and qualified in USEPA's 2004 RFFS Addendum. One primary focus of the model analysis presented in the 2004 RFFS was to evaluate source depletion rates for "cap" and "no cap" remedies. However, because this SC-FFS does not evaluate alternatives with a Landfill cap, the source depletion rates for alternatives presented in this SC-FFS are sufficiently similar that their comparison is not relevant to the discussion of short-term effectiveness; because the source depletion rates were considered in selecting Alternative SC-A in the 2004 AROD, they should be acceptable for Alternative SC-Ex and are not a differentiating factor.

To preliminarily evaluate Alternatives SC-A and SC-Ex with regard to potential cleanup times, a particle capture time evaluation was performed using the 2004 RFFS model; this evaluation is included in Appendix D. The particle capture time evaluation identified differences in advective ground water flow times through the Landfill between SC-A (which maintains ambient hydraulic conditions) and SC-Ex (which induces increased hydraulic gradients by active extraction of ground water at the Landfill toe). Discussions of the relative differences in advective flow rates are presented in Sections 5.5.6 and 5.6.6, and comparative discussion are presented in Sections 5.7.3, 5.7.7, and 5.7.11.

5.2.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. Specifically, evaluation of this criterion considers:

- the ability to construct and operate components of the alternatives and potential technical difficulties and unknowns;
- the ease of undertaking additional remedial action;
- the ability to monitor the performance and effectiveness of the remedy and the ability to evaluate the risks of exposure should the monitoring be insufficient to detect a failure of

the remedy;

- administrative feasibility (i.e., activities that are necessary to coordinate with other offices and agencies for permits, rights-of-way, etc.); and
- the availability of services, capacities, materials, equipment, and specialists.

5.2.7 Cost

Costs presented in this evaluation are essentially the same costs as presented in the 2004 AROD, except where noted. For consistency, unit costs used in the 2004 AROD cost estimates were not modified, and new costs were based upon estimates from vendors or engineering judgment. Cost estimating procedures used for the 2004 RFFS are summarized in USEPA costing guidance (USEPA, 1985, 1987, and 2000). The purpose of the cost evaluation is to compare how an alternative's cost impacts the overall "cost-effectiveness" of the alternative over time. These "study estimate" costs are expected to provide an accuracy of +50 percent to -30 percent and were prepared for the Site using data available from the RI (GZA and Wehran, 1988), 1991 FS (HMM, 1991), 1991 ROD, FES (HMM, 1990), pre-design activities (Golder, 1995), the 100 percent design completed by Golder (Golder, 1996), and the Final Bioremediation Pilot Assessment (Envirogen and XDD, 2001). They do not include pre-design activity or design development costs. They do not represent construction cost estimates or cost at completion. The individual components of the cost estimates are defined as:

- Capital Costs: Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs associated with installation and implementation of remedial alternatives. Direct costs include expenditures for the equipment, labor, and materials necessary to install remedial actions. Indirect costs include expenditures for engineering, financial, administration, and other services that are not part of actual installation activities.
- Annual O&M Costs: Annual O&M costs are post-construction costs necessary to ensure the continued effectiveness of a remedy.
- Present Worth Analysis: A present worth analysis is used to evaluate expenditures that occur over different time periods. This analysis provides a single figure representing the

amount of money that, if invested in the base year at a given interest rate, would be sufficient to cover costs associated with the remedial action over its planned life.

- Cost Sensitivity Analysis: A sensitivity analysis assesses the effect that variations in specific assumptions associated with the design, implementation, operation, discount rate, and effective life of an alternative may have on the estimated cost of the alternative.

5.2.8 State Acceptance and Community Acceptance

The final two criteria, State Acceptance and Community Acceptance, are typically evaluated by the USEPA following a public comment period on a Proposed Plan for the selected remedy and are considered by the USEPA in arriving at a ROD. The results of the Responsiveness Summary issued with the 1991 ROD were included in Appendix D of the 2004 AROD. A summary will be included in the final draft version of this report, as directed by the USEPA.

5.3 METHOD

As discussed in Section 1.0, this SC-FFS was performed in accordance with USEPA guidance for conducting a detailed evaluation of alternatives in a CERCLA FS (USEPA, 1988 and 1991). The technology screening and development of alternative steps identified in USEPA FS guidance were not re-created, although the analyses performed in the 1991 FS are referenced (HMM, 1991).

Estimated costs presented in the 1991 FS (HMM, 1991) were updated in the 2004 RFFS to account for then-current materials and labor rates and inflation between 1991 and 2003 in accordance with standard FS cost-estimating protocols and USEPA guidance (USEPA, 1985, 1987, and 2000). The costs presented in the 2004 RFFS were updated primarily using unit costs obtained from R.S. Means Environmental Remediation Cost Data (2002). Certain capital costs that were not readily available in R.S. Means were obtained from contractors and vendors. Present worth calculations were then performed using the updated annual O&M costs and a revised discount rate of 7 percent (USEPA, 2000; lower than the 10 percent used in the 1991 FS to reflect current economic conditions). Costs presented in this SC-FFS are consistent with costs presented in the 2004 RFFS and the 2004 AROD.

The No Action Alternative is briefly discussed in Section 5.4, referencing its detailed evaluation in the 2004 RFFS. Detailed evaluations of the two active SC remedial alternatives described in Sections 4.5 and 4.6, using the seven criteria discussed in the preceding section, are presented in Sections 5.5 and 5.6, respectively. State and Community Acceptance are discussed in the comparative analysis section (Section 5.7.10).

5.4 NO ACTION ALTERNATIVE (SC-1)

The components of the No Action Alternative were described in greater detail in Section 4.4. To summarize, the No Action Alternative consists solely of long-term monitoring of ground water, surface water, sediment, and Landfill gas, although institutional controls established by the City of Dover and Town of Madbury will mitigate potential human health risks. The No Action Alternative was evaluated in detail in the 2004 RFFS (Section 5.4, pages 5-5 to 5-12). As described and analyzed in the 2004 AROD, the No Action Alternative was considered to be not an acceptable alternative for the Landfill and Site and was not selected as the AROD remedy. Available information does not indicate that this assessment of the No Action Alternative is likely to change. Accordingly, it is not evaluated in detail in this document. The detailed evaluation of this alternative can be reviewed in Section 5.4 of the 2004 RFFS (pages 5-5 to 5-12). For comparison, the cost estimate for the No Action Alternative presented in the 2004 RFFS is included herein as Tables 5-3 and 5-4.

5.5 SC-A REMEDY

5.5.1 Overview

The elements of the SC-A remedy were described in Section 4.5. To summarize, this SC alternative included:

TABLE 5-3
NO ACTION ALTERNATIVE - COST ESTIMATE
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

COMPONENT	QUANTITY	UNIT	UNIT COST	CAPITAL COST	ANNUAL O&M COST
LONG TERM MONITORING					
60 Wells - 2x/yr - 10% QA/QC					
- VOCs and Metals Analysis	159	ea	$315		$50,085
Sediment and Surface Water Sampling					
- Twice yearly, 3 locations	6	ea	$350		$2,100
Landfill Gas Samples (4 Summa Cans, Twice Annually)	8	ea	$350		$2,800
Labor - Landfill Gas Sampling (1 day/month)	96	hr	$70		$6,720
Labor - Ground Water, Soil, Surface Water Sampling	640	hr	$70		$44,800
EPA Tier II Data Validation - 2 events	120	hr	$90		$10,800
2 Reports - 4 days/report @ 8hr/day	64	hr	$90		$5,760
			Subtotal	$0	**$123,065**
	Contingency		10%	$0	
	Project Management		5%	$0	
	Remedial Design		6%	$0	
	Construction Management		6%	$0	
	TOTAL COST			$0	**$123,065**
	Discount Rate	7%			
	Years of Operation	30			
	PRESENT WORTH COST				**$1,527,119**

Notes:
1. This estimate is the same estimate presented in the draft 2004 RFFS dated January 30, 2004. Previous notes presented below.
2. Costs based on current costs for conducint samplin events at the Site, adjusted for number of sampling locations.
3. Project Management, Remedial Design and Construction Management rates based on "A Guide to Developing Cost Estimates During the Feasibility Study" July 2000, EPA 540-R-00-002 pg 5-13.
4. Discount rates based on "A Guide to Developing Cost Estimates During the Feasibility Study" July 2000, EPA 540-R-00-002 pg 4-4.

TABLE 5-4
NO ACTION ALTERNATIVE
COST CONTINGENCIES AND SENSITIVITY ANALYSIS
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

SC-1: NO ACTION ALTERNATIVE TIME SENSITIVITY ANALYSIS

REMEDY	YEARS OF OPERATION	PRESENT WORTH COST
SC-1	15	$1,120,865
	30	$1,527,119
	45	$1,674,364

Notes:
1. This sensitivity analysis is the same as presented in the draft 2004 RFFS dated January 30, 2004. Previous notes presented below.
2. Sensitivity Analysis based on "A Guide to Developing Cost Estimates During the Feasibility Study" July 2000, EPA 540-R-00-002 pg 5-15.

- augmentation and maintenance, as warranted, of the vegetated, permeable protective cover currently on the Landfill;

- evaluation of the appropriateness of the Landfill cover at the conclusion of the ground water remedy;

- closure of the perimeter ditch by backfilling;

- removal of sediment impacted by arsenic above 50 mg/Kg from the drainage swale and perimeter ditch for off-site disposal;

- construction of an aerobic treatment trench along the southern and eastern boundary of the Landfill to treat COC-impacted ground water;

- construction of a vertical hydraulic barrier (e.g., sheet pile wall) near the northeast corner of the Landfill along Tolend Road;

- construction of a ground water extraction and *ex situ* treatment system near the southwest corner of the Landfill to treat and manage THF-impacted ground water; and

- evaluation of appropriate remedial measures for identified source areas in the Landfill that may not be adequately treated by the SC component.

Of these elements, this SC-FFS evaluation is focused upon comparative evaluation of two elements of Alternative SC-A (the aerobic treatment trench along the southern boundary of the Landfill and THF capture, treatment, and recirculation system near the southwest corner of the Landfill) with an alternative approach involving ground water extraction at the Landfill toe. Important considerations in this evaluation included new information obtained from PDIs currently in progress pursuant to the 2004 AROD. This information included:

- the identification of the Southern Plume center of mass in relatively close proximity to the southwest corner of the Landfill;

- identification of an area of relatively high concentrations of VOCs in ground water in the northwest corner of the Landfill; and

- the absence of other localized areas of significant COC impacts and the presence of relatively dilute concentrations of COCs along the toe of the Landfill and areas upgradient.

This information affected primarily the analysis of implementability and cost effectiveness of the remedy. With regard to implementability, the PDI information affected assessment of technical uncertainties associated with Alternative SC-A, including several that were identified in the 2004 AROD and several prompted by the new information. These uncertainties included:

- the constructability of the trench and air sparging system at depth, particularly at the eastern corner of the Landfill;
- the treatability of THF at the southwest corner of the Landfill;
- the adequacy of residence time at the northeast corner of the Landfill to attain treatment Performance Standards due to higher ground water flow rates in the area;
- ability to reliably demonstrate trench performance through monitoring inside and outside the trench;
- potential clogging of the trench backfill or at the interface with the native aquifer material by inorganic solids and possible biological growth during active operation of the trench;
- the long-term stability of precipitated arsenic after active operation of the air sparging trench ends;
- potential hydraulic interferences between the Southern Plume ground water extraction system and the trench and THF interception and recirculation system at the southwest corner of the Landfill; and
- potential interference or adverse impacts on the Northwest Landfill hotspot and remedy from the THF recirculation system.

5.5.2 Overall Protection of Human Health and the Environment

Alternative SC-A provides a moderate long-term overall protectiveness of human health by facilitating continued biodegradation of COCs in the Landfill waste mass and flushing residual hazardous constituents present in the Landfill to a treatment trench for permanent treatment. The protective soil cover on the Landfill eliminates the potential for dermal exposure to landfilled waste and facilitates treatment of COC-impacted wastes in the waste mass by natural attenuation processes and by flushing of leachate to the *in situ* treatment system. Augmenting the soil cover does not involve disturbing solid waste in the Landfill, preventing potential generation of fugitive dust, organic vapors, and odors. Backfilling the perimeter ditch prevents human and ecological receptor exposures.

Subject to the technical uncertainties identified in Section 5.5.1, potential future exposures to leachate and impacted ground water generated by the Landfill will be eliminated through construction and operation of the aerobic treatment trench. Intercepting and treating leachate-impacted ground water protects the environment by reducing the potential for impacts in local surface water bodies (the Cocheco River and the Bellamy Reservoir). Laboratory and field-scale studies (Envirogen, 1995 and 1996) completed at the Site and analyses performed as part of the FFS (Appendix J of the 2004 RFFS) established that the target constituents will be treated through a combination of volatilization, anaerobic and aerobic biodegradation, and, in the case of arsenic, oxidation and precipitation/sorption as a result of redox conditions altered by injection of air in the treatment trench. Captured vapors from the treatment trench can, if necessary, be discharged through a treatment system to mitigate potential risks (Appendix M of the 2004 RFFS). The treatment trench will intercept Landfill leachate and prevent its migration from the source area.

Installation of a sheet pile wall along the northeast border of the Landfill will contain impacted ground water and direct flow within the east portion of the Landfill into and through the treatment trench. The sheet pile wall will limit the potential migration of impacted ground water and leachate from the north portion of the Landfill to the east across Tolend Road toward residential properties located to the north of the Landfill along Glen Hill Road. The sheet pile wall will also limit possible hydraulic impacts associated with Alternative SC-A on residential properties along Glen Hill Road. Comparison of model simulations of ambient hydraulic conditions (i.e., No Action) and the alternative remedies presented in the 2004 RFFS indicated that the water table along Glen Hill Road will not change significantly and that the water table in the vicinity of these residential properties may be slightly lower under Alternative SC-A (Section 4.4 and Figures 4-1 and 4-37 of Appendix N, 2004 RFFS). Model simulations indicated that areas to the north (of the northwest portion) and west of the Landfill became "flooded" under Alternative SC-A, indicating that the water table (which is already shallow in these areas) would intersect the ground surface. These areas are currently occupied by forested wetlands (seasonally characterized by areas of standing water) and are not developed, nor are they developable under current wetlands regulations.

Protection of the environment is high because of the long-term reduction and elimination or immobilization of the COCs currently present within the Landfill. The protective soil cover on the Landfill and the filled perimeter ditch will protect human and terrestrial receptors from potential exposure to Site COCs in Landfill waste and perimeter ditch sediment. The protective cover helps maintain existing vegetation, which includes poplars, and habitats on the Landfill. Poplars have been identified as effectively controlling shallow COC impacts at a number of remedial sites (Schnoor et al., 1995; Newman et al., 1997; and Schnoor 2002).

Filling the perimeter ditch (a component included in both SC-A and SC-Ex) will permanently alter approximately 1.2 acres of wetlands (i.e., the estimated footprint of the existing perimeter ditch, which is estimated to be 10 feet wide (on average) and 5,220 linear feet long; Figure 4-1). The estimated footprint of treatment trench construction activities at the downgradient toe of the Landfill is approximately 2 acres of land (see Figure 4-1). The estimate is based upon the conceptual design for the trench presented in the 2004 RFFS that was estimated herein to be 30 feet wide and 2,900 feet long. Construction operations are expected to temporarily impact an additional 1.2 acres of forested wetland. This area estimate includes the likely location of an access road along the trench for conveyance piping, utilities, and access the top of the trench. After construction is completed and restoration activities are performed, permanent wetland impacts are estimated to affect approximately 1.2 acres (i.e., the location of the trench that overlaps the boundary of the forested wetland complex.). The estimated permanent alteration to the forested wetlands is estimated to be 0.5 percent of the forested wetlands complex that surrounds the Landfill.

The treatment trench will also eliminate long-term migration of leachate from the Site.

Maintaining the existing soil cover on the Landfill allows infiltration of precipitation into the Landfill and, hence, maintains current COC flushing and biodegradation, as well as recharge to local wetlands.

5.5.3 Compliance with ARARs

Action-Specific: The action-specific ARARs associated with this alternative are identified in Table 5-2A located at the end of Section 5. Alternative SC-A will meet action-specific ARARs. Federal and State requirements for hazardous waste landfills are not applicable to the Landfill itself because the Landfill did not receive RCRA wastes after 1980. However, because hazardous substances will temporarily remain beneath the permeable cover during treatment, certain of these requirements are relevant and appropriate. Most relevant among these requirements are those for closure and post-closure. A facility at which hazardous waste has been disposed must be closed in a manner that reduces or eliminates potential future off-site migration of hazardous wastes if such wastes are to remain on-site after closure. The proposed augmented soil cover promotes COC biodegradation within and flushing from the solid waste to permanent treatment so that hazardous constituents will not remain on-site after closure at concentrations that will pose unacceptable risks to human health. Biodegradation in the Landfill mass and the *in situ* leachate and ground water treatment system addresses these requirements by preventing COC migration off-site.

In situ treatment within a treatment trench does not require compliance with NPDES or pretreatment regulations because there are no discharges to the Dover POTW or to surface water. On-site treatment may produce residuals (e.g., impacted soil excavated during trench construction) that are hazardous wastes requiring management in compliance with RCRA. For such treatment residuals and excavated soil and sediment, RCRA will be applicable if the material is characterized as hazardous waste under State hazardous waste rules.

A number of federal and State requirements are applicable to construction and long-term operation of an on-site ground water collection system for the southwest corner THF recirculation system, if necessary. Ground water treated on-site and discharged to the Landfill surface will comply with re-injection water quality requirements established in State Ground Water Discharge Rules. On-site treatment may produce residuals, such as sludges bearing metals and VOCs, spent carbon, and wastes from periodic maintenance and cleaning of treatment equipment. These residuals may be hazardous wastes requiring management in compliance with State hazardous waste rules.

Chemical-Specific: The chemical-specific ARARs associated with this alternative are identified in Table 5-2B located at the end of Section 5. Alternative SC-A will meet chemical-specific ARARs. The SC aerobic trench and southwest extraction system will intercept COC-impacted on-site ground water and treat it to cleanup standards, ensuring protection of downgradient ground water and surface water. However, if the trench is not effective at permanent sequestration of arsenic, then compliance with chemical-specific ARARs may not be achieved for arsenic, depending upon the rate at which it is re-released to ground water.

Arsenic-impacted sediment in the perimeter ditch and drainage swale will be removed, thereby meeting ARARs. Mitigation measures will be employed to minimize or eliminate dust and airborne particulate matter during localized maintenance of the protective cover, soil excavation for treatment trench construction, or other on-site activities. Off-gas from the treatment trench is expected to meet applicable ARAR (i.e., New Hampshire AALs; Appendix M of 2004 RFFS); however, treatment can be applied if necessary to achieve compliance with these standards.

Location-Specific: The location-specific ARARs associated with this alternative are identified in Table 5-2C located at the end of Section 5. Alternative SC-A will meet location-specific ARARs. System design will incorporate measures to reduce impacts of construction and operation on the relatively small areas of local forested wetlands affected. Filling the perimeter ditch prevents exposure to contaminated sediments, as well as potential re-contamination of the sediments. On-site facilities will be sited and constructed in accordance with local building codes.

5.5.4 Long-Term Effectiveness and Permanence

Operation of the treatment trench will provide effective, long-term treatment of ground water and leachate migrating out of the Landfill. Maintenance of the permeable Landfill cover will result in continued reduction in COC mass within the Landfill through flushing and continued microbial activity sustained by infiltration and the organic matter in the solid waste. The COCs will be flushed from the Landfill solid waste to the treatment trench for permanent treatment. In the long-term, there will not be untreated hazardous substances left on-site at concentrations that pose unacceptable risks. However, there are uncertainties regarding potential remobilization of precipitated arsenic that may reduce the long-term effectiveness and permanence of arsenic treatment. The rate at which arsenic is remobilized is significantly influenced by the type of iron-based compounds to which the insoluble arsenic becomes adsorbed during the process of aerobic mineral formation (Pedersen, 2006). Under reducing conditions, goethite and ferrihydrite both retained a significant mass of arsenic until approximately 50 percent of the total iron was reduced to Fe^{+2}, while the reduction of lepidocrocite showed an immediate increase in soluble arsenic upon exposure to reducing conditions. As noted in Appendix K-2 of the RFFS, the iron precipitant expected to be formed within the treatment trench will be principally in the form of goethite. The rate at which arsenic is re-mobilized will thus be affected by whether and the rate at which reducing conditions are re-established after completion of remedial action and the rate at which iron is re-mobilized, both of which are difficult to reliably predict at present.

Hydraulic model results indicated that the aerobic treatment trench will intercept impacted ground water emanating from the Landfill, although operation of the Southern Plume ground water extraction system relatively close to the western end of the trench may result in hydraulic interference with trench capture in this area, necessitating additional capital costs or operational attention to mitigate such interference. The results of the modeling were used to aid in the design of the aerobic treatment trench, such as projection of ground water velocities used to determine the length of trench segments (Appendix N of 2004 RFFS). Some velocities near the vertical hydraulic barrier constructed along Tolend Road under startup and long-term operating conditions (prior to the potential need to clean trench backfill) will be greater than 2 ft/day. However, the trench stripping analysis projects effective treatment of organic COCs at ground water velocities as high as 3 ft/day (Appendix J of 2004 RFFS), with the possible exception of a hotspot area of THF in the southwest corner of the Landfill. An extraction and *ex situ* treatment system with discharge of treated ground water back into the Landfill is proposed to address this issue.

Certain residuals may require off-site disposal, principally impacted soil excavated during construction or rejuvenation of the treatment trench. Residuals removed from the trench will be properly handled and treated or disposed of off-site in compliance with ARARs. Numerous disposal facilities are available to treat and dispose of impacted soil and arsenic-bearing sludge.

Contingency Measures to Treat THF: The results of the stripping capacity analysis for THF indicated that treatment of measured average input concentrations of THF (less than 146 μg/L), between Landfill toe well clusters MW-101 and SC-7, to ICLs/AGQSs levels can be accomplished at the design air flow rates (illustrated in Figure 5-7, page 5-65 of the 2004 RFFS). Potentially higher THF concentrations entering the trench between well clusters SC-10 and MW-101 (located near the southwest corner of the Landfill) could exceed the treatment capacity of the trench. Additional information (identified during the Air Sparging Trench and Southern Plume PDIs) presented in Section 1.4.9, indicated that THF concentrations could range up to 5,500 μg/L along the southwest corner of the Landfill. This localized condition may be addressed with an extraction and *ex situ* treatment system constructed in the vicinity of the southwest corner of the Landfill. Because this remedy "requires" a contingent approach to treat THF, the overall effectiveness of the basic trench design is complicated by the requirement for additional extraction, treatment, and injection equipment that may hydraulically interfere (i.e., affect ground water flow pathways) with performance of the trench remedy. In addition, there may be hydraulic interferences from the

Southern Plume extraction system, and the THF recirculation system may adversely impact the Northwest Landfill source area (e.g., dispersing the source or changing ground water flow in the area) or interfere with the hotspot remedy.

During design, a monitoring plan will be developed to provide a mechanism to detect concentrations of THF above the treatment trench capacity, and a suitable design will be selected for an *ex situ* treatment system to meet re-injection water quality standards and other ARARs. This treatment system will be designed to treat ground water extracted from wells upgradient of the treatment trench to meet re-injection standards for COCs. The ground water will be re-injected into the Landfill to maintain the water balance for the SC remedy (per USEPA's letter dated October 10, 2003 in Appendix O of the 2004 RFFS). Although the treatment technology is proven and can meet re-injection water quality standards, the long-term effectiveness of this type of system is considered moderate because of the potential for re-injected, treated water to interfere with flow dynamics near the trench. In addition, recirculation of the treated ground water into the Landfill footprint may cause unpredictable impacts on the Northwest Landfill source and remedial activities for that source.

Long-term O&M of the extraction and treatment system will be necessary to achieve and maintain hydraulic control in potential source areas in the southwest corner of the Landfill and compliance with re-injection water quality standards. Periodically, transfer and extraction pumps will require replacement; however, this replacement will not pose significant risks because the ground water extraction pumps and the entire treatment system can be shutdown for the relatively short period required to complete replacement without losing hydraulic control. Overall, the treatment system is expected to function adequately, and normal O&M should be relatively easily managed.

Maintenance of the Protective Cover: Augmentation and maintenance of the protective cover will provide effective long-term protection against contact with the solid waste present in the Landfill. On completion of the SC remedy, the cover system will be evaluated to assess whether additional measures are required to comply with New Hampshire ARARs for landfills at which operations ceased before 1981 and at which hazardous constituents are not adversely affecting ground water quality.

Landfill Perimeter Ditch Filling: Filling of the Landfill perimeter ditch will provide effective, long-term reliability in eliminating potential exposures to COC-impacted sediment at the Site by eliminating the exposure pathway. Results of hydraulic modeling indicated that filling the perimeter drainage ditch will cause an increase in water table elevations near and within the Landfill of approximately 1 to 2 feet (Appendix N of the 2004 RFFS).

Based upon a comparison of the hydraulic conditions associated with the No Action Alternative (i.e., essentially ambient conditions), the aerobic treatment trench is not projected to have significant long-term impacts on the extensive forested wetlands south and east of the Landfill. The results of model simulations indicated that, with the trench installed and operating, hydraulic conditions to the south and east of the Landfill will remain similar to ambient conditions (i.e., the areas of flooded cells in model layer 1 and the typical water table). As discussed in Sections 4.4.3 and 4.4.4 of Appendix N of the 2004 RFFS, implementation of Alternative SC-A, including filling the perimeter ditch, will result in increases in the elevation of the water table to the west, southwest, and north (north of the northwest portion) of the Landfill. The areas where an increase in flooded cells was observed correspond to areas that are currently occupied by forested wetlands and where the water table is currently generally located close (i.e., less than several feet below) to the ground surface. These areas are not developed and are not developable under current wetland regulations.

Treatment Trench Off-Gas Treatment and Air Dispersion Modeling: Treatment trench off-gas is not expected to require treatment to comply with ARARs. Air dispersion modeling was performed to evaluate the potential impacts of VOC emissions from the proposed aerobic treatment trench to ambient air and to demonstrate compliance of those VOC emissions with the New Hampshire Code of Administrative Rules (NHCAR) Env-A 1400 (Appendix M of the 2004 RFFS). Use of the SCREEN2 Model for this purpose was described in Section 5.6.3 of the 2004 RFFS (page 5-40 and Table 5-8 on page 5-41). If monitoring indicates that treatment is required, it will likely employ vapor phase carbon that will be regenerated or disposed of off-site when spent.

In the long-term, there will not be untreated hazardous substances left on-site at concentrations that pose unacceptable risks. Certain residuals may require off-site disposal, principally impacted soil excavated during construction or rejuvenation of the treatment trench. Residuals removed from the trench will be properly handled and treated or disposed of off-site in compliance with ARARs. The quantity of residuals will depend on the length of operation, the size of the affected area, and the mode of removal. Numerous disposal facilities are available to treat and dispose of impacted soil and arsenic-bearing sediment.

5.5.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

5.5.5.1 Overview

The reduction of COC toxicity, mobility, or volume through SC measures is divided into three categories based upon the mode of reduction. The three categories are removal of VOCs through volatilization and biodegradation, removal/immobilization of arsenic through precipitation/sorption, and, if necessary, treatment of trench off-gas. The treatment of VOCs and arsenic at the source via these removal processes is consistent with the NCP's preference for treatment.

5.5.5.2 Removal of Volatile Organic Compounds through Volatilization and Biodegradation

Organic COC mass in impacted ground water and leachate will be permanently reduced by a combination of biodegradation and volatilization in the treatment trench. As described in Section 4.5, the aerobic treatment system consists of a trench with backfill engineered to provide *in situ* flow-through treatment of COCs dissolved in ground water exiting the toe of the Landfill. The results of treatability studies (Envirogen, 1995), field testing (Envirogen, 1996), and additional stripping analyses (Appendix J of the 2004 RFFS) indicated that a treatment trench system can remove most of the concentrations of organic COCs that are present at the Site by volatilization. Thus, the toxicity, mobility, and volume of VOCs will be permanently reduced. Performance of the trench at the northeast corner of the Landfill will be monitored carefully to ensure that the higher ground water flow rates in the area do not reduce residence time in the trench below the level necessary to achieve performance standards.

A review of the literature and contacts within the industry, described in Appendix L-2 of the 2004 RFFS, identified four sites where engineered air sparging trenches were designed, built, and operated. As summarized in Table 5-9 of the 2004 RFFS, the four air sparging trenches achieved significant reduction in the ground water concentrations of the COCs entering the trenches. Although sparging trenches that were monitored for arsenic removal were not identified, arsenic co-precipitation with iron is expected to be feasible based upon the analyses presented in Appendix K-5 of the 2004 RFFS (page 2 and Table 2). A monitoring plan will be developed during remedy design to evaluate the effectiveness of the treatment trench for arsenic removal. The organic constituents of concern at the Site, with the exception of THF, have Henry's Law constants that are well within the range for which volatilization is a suitable remedial technology and are, therefore, expected to be effectively stripped from the trench to acceptable concentrations (i.e., ICLs/AGQSs).

The results of stripping capacity analyses for THF (Appendix J of the 2004 RFFS) indicated that treatment of measured average input concentrations of THF (less than 146 μg/L) between Landfill toe well clusters MW-101 and SC-7 to ICLs/AGQSs levels can be accomplished at design air flow rates. However, higher THF concentrations entering the trench between well clusters SC-10 and MW-101 could exceed the treatment capacity of the trench. This localized condition can be addressed with a ground water extraction and *ex situ* treatment system constructed in the vicinity of the southwest corner of the Landfill to attain re-injection standards for COCs. The technical implementability of an air sparging trench is discussed further in Section 5.5.7.

5.5.5.3 Removal/Immobilization of Arsenic through Precipitation/Sorption

The aerobic conditions created in an *in situ* aerobic treatment trench are expected to cause dissolved arsenic and other reduced minerals to precipitate in the void spaces within the trench backfill material, significantly reducing the dissolved arsenic concentrations in ground water leaving the trench. Thus, the toxicity (i.e., bioavailability) and mobility of arsenic will be reduced with a change in volume. Removal of arsenic by amorphous iron oxides under aerobic conditions (natural or enhanced) has been extensively studied (see Table 5-10 and Table 2 of Appendix K-5 of the 2004 RFFS), and sparging has been demonstrated to be an effective *in situ* remediation approach for arsenic-contaminated ground waters in several studies (Folan and Sutton, 1995; Sarkar and Rahman, 1985; and Mamtaz et al., 1990). Additional information regarding arsenic removal and sequestration mechanisms is presented in Section 5.6.4.1 of the 2004 RFFS (page 5-46).

Based upon information summarized in Appendix K-5 of the 2004 RFFS, arsenic is expected to be removed via co-precipitation with and sorption on metal/iron oxyhydroxides in the trench. However, the stability of the arsenic precipitate will be influenced by prevailing geochemical conditions and is potentially reversible if reducing conditions are reestablished when sparging ceases. The resulting arsenic concentration in ground water will depend upon the rate of change in the geochemistry and the kinetics of arsenic dissolution. The stabilization of arsenic in the trench consolidates the mobile arsenic present at the Site into a smaller volume (i.e., that of the trench), but does not reduce it; however, it reduces arsenic toxicity by inducing a valence state change. Uncertainty regarding long-term effects of changes in geochemistry following trench shutdown limits the certainty of reduction of arsenic toxicity, mobility, and volume through treatment.

In the event that removal of arsenic or precipitate from the trench backfill material is required, acid washing is proposed as one of a number of potential remedial approaches to rejuvenate the backfill material. The iron-arsenic complex (arsenic contained iron oxyhydroxides) would be removed from the trench through dissolution of the precipitate and pumping of the solution from the trench for disposal (Appendix K-5 of the 2004 RFFS). Chemical reducing agents (e.g., dithionite) can be used under less acidic (higher pH) conditions. Excavation and replacement of the trench backfill material is also an option, if warranted. However, this approach may damage or destroy existing piping and equipment in the trench and require re-installation. The techniques to rejuvenate the backfill material and to remove the iron-arsenic complex from the trench are discussed in greater detail in Appendix K-5 (pages 5 and 6) of the 2004 RFFS.

5.5.5.4 Treatment Trench Off-Gas

Treatment trench off-gas is not expected to require treatment to comply with ARARs. Air dispersion modeling performed to evaluate potential impacts of VOC emissions to ambient air from the aerobic treatment trench demonstrated compliance with the provisions of Env-A 1400 (Appendix M of the 2004 RFFS), specifically with the Annual and 24-hour AAL criteria. Accordingly, because estimated air emissions are significantly below the AALs, controls are not expected to be required for treatment trench off-gas.

5.5.6 Short-Term Effectiveness

Until remediation goals are met, potential future human exposures to off-site ground water impacted above AGQSs (concentrations protective of human health exposures through consumption of drinking water) are theoretically possible. However, institutional controls already established by the City of Dover and Town of Madbury, including the provision of Dover municipal water supply, will prevent installation and use of private water supply wells in affected areas. In addition, the 2004 AROD required that a GMZ be established at the Site pursuant to New Hampshire regulations. As summarized in Section 1.4.3, the Group submitted a GMZ permit application in November 2007 to the NHDES that is currently in review. The GMZ will provide additional assurance that ground water will not be used at the Site.

The short-term effectiveness of Alternative SC-A is considered moderate. The trench is proposed to be constructed in segments, and pilot testing of one segment to demonstrate trench performance prior to construction of the rest of the trench is required by the 2004 AROD. Accordingly, construction will likely extend over several years, including bidding, selection of a contractor, and construction of the aerobic treatment trench, vertical barrier, and ground water recirculation system. After pilot testing is completed, equipment will be remobilized for another construction period that is anticipated to be one to two construction seasons. It is expected that the treatment trench and recirculation system will be fully operational within several weeks to several months of construction completion and initial system optimization.

A temporary increase in traffic, noise, and, possibly, nuisance dust will be associated with construction activities, primarily during excavation of the treatment trench. Soil brought to the ground surface during trench construction will largely be saturated, minimizing fugitive dust generation. Dust emissions can be managed, as required, with standard dust control measures. Based upon VOC concentrations in ground water in the proposed area of the treatment trench, VOC concentrations released to air from the soil will be well below applicable State AALs (Appendix M of the 2004 RFFS). Relatively few and small areas of the Landfill cover require soil augmentation and associated traffic and noise will, therefore, be limited in both extent and duration. During the active construction period, potential risks to workers will be managed by Occupational Safety and Health Administration (OSHA) training and using typical construction safe working practices and personal protective equipment. Potential short-term risks to public health during operation are negligible due to the *in situ* nature of the remedy dependent on maintenance of system components.

Construction in the forested wetlands at the margins of the downgradient Landfill toe will affect vegetation and habitat. Excavation of the trench will likely require clearing of trees and local disturbances to the wetlands that have developed in the man-made perimeter ditch. Using existing roadways within the adjoining wetlands, when practicable, will further reduce potential disturbances. Temporary roadways may be required to provide access to the areas south and east of the Landfill for construction equipment and delivery of treatment trench construction materials. The design of the treatment trench will include measures to mitigate significant impacts to the wetlands that may be caused during its installation.

The short-term effectiveness of Alternative SC-A is considered high with regard to treatment of leachate and on-site ground water because ground water and leachate will be intercepted and treated immediately downgradient of the Landfill. The treatment trench will prevent migration of untreated leachate and ground water to downgradient ground water and surface water bodies. If the existing cover on the Landfill is well maintained, it will continue to effectively prevent contact of human and environmental receptors with landfilled waste.

Previous RFFS modeling efforts were updated to evaluate the advective ground water flow rate associated with Alternative SC-A as part of an effort to preliminarily evaluate cleanup times in comparison to those for Alternative SC-Ex. The results of previous particle track simulations were revised to estimate "flow-through" times associated with four particles under the two alternatives. The evaluation included two particles located at the upgradient (i.e., north) border of the Landfill (historical particles "F" and "G"), and two particles located within the western lobe (historical particle "H") and eastern lobe (historical particle "D") of the Landfill. Modeling of particle tracks for SC-A (Appendix D) indicated that under ambient advective flow conditions, theoretical particle travel times from the upgradient border of the Landfill ranged from 14 to 115 years and four locations within the Landfill ranged from 2 to 17 years. For both sets of particles, faster travel times were associated with particles that moved predominantly within the US unit (as compared to particles that moved predominantly within the UUI and LUI units prior to reaching the toe of the Landfill). A comparison of SC-A potential travel times with travel times associated with alternative SC-Ex is presented in Section 5.7.7.

5.5.7 Implementability

5.5.7.1 Technical Feasibility

Alternative SC-A is moderately implementable, subject to uncertainties identified in Section 5.5.1. Experience is available in construction and operation of the individual elements of the system, although they are being employed in an innovative combination for which there are some precedents. The necessary equipment and techniques to construct this alternative are well developed and readily available commercially. Sufficient land is available for construction and operation of the treatment trench. The most challenging construction component of Alternative SC-A involves the use of deep excavation techniques for components installed at depths greater than 30 feet. However, techniques involving sheet piles and biodegradable slurry have been successfully employed to construct similar trench systems at depth at contaminated site cleanups (Appendix L-1 of the 2004 RFFS) and for a wide range of large-scale construction applications. The Tolend Road hydraulic barrier is easily constructed using readily available materials and techniques (e.g., sheet pile). The installation and operation of the components of ground water extraction and *ex situ* treatment systems are well understood from long experience with such systems. Accordingly, the southwest corner extraction and *ex situ* treatment system, to address THF concentrations in this area, can be constructed using readily available equipment and proven construction methods. Design and operation of this system will require care to limit potential interference from the Southern Plume extraction system and to mitigate potential adverse impacts on the Northwest Landfill source and its remedy.

Air sparging is a proven technology for volatilization and aerobic biodegradation of VOCs and has been demonstrated to successfully oxidize and precipitate or sorb metals (including arsenic) present in ground water. Appendix L-2 of the 2004 RFFS provides more detailed information regarding application of air sparging technology and the potential effectiveness of an air sparging trench to treat the COCs present at the Site. There are hundreds of sites across the United States where air sparging has been successfully used as a remedial technology for both source remediation and/or as a containment/treatment barrier. Additional information regarding air sparging applications was presented in Section 5.6.6 (pages 5-56 through 5-58) and Figure 5-1 of the 2004 RFFS.

A sparging trench is an engineered trench typically constructed perpendicular to the ground water flow direction. The need to construct an engineered trench as an air sparging barrier at the Landfill is warranted by the presence of low permeability soil lenses in the aquifer that significantly inhibit the vertical migration of the sparged air/vapors. The primary difference between the sparging trenches employed at other sites and the one planned for the Dover Landfill site is the depth. The case studies involved trenches that were typically 30 feet deep (one ranged up to 40 feet deep), while the proposed aerobic treatment trench may be 50 feet to as much as 70 feet deep in some segments. Aside from construction (previously discussed), the primary implication of the difference in trench depths is the higher pressure head that will have to be overcome to inject the air at depth. At a depth of 60 feet (average for deeper trench), the pressure head will be approximately 26 pounds per square inch (psig), gauge (; Appendix J of the 2004 RFFS). Pump and compressor configurations capable of injecting air at such pressures are readily available from such manufacturers as Ingersoll-Rand-Air Solutions Group and Saylor-Beall Manufacturing Company.

With respect to contaminant removal by volatilization, *in situ* air sparging depends on mass transfer from the aqueous or residual liquid phase to the vapor phase. For VOCs, a constituent must have a (dimensionless) Henry's Law constant greater than 4.15×10^{-4} to be successfully sparged from an aqueous phase (Brown et al., 1991). The Henry's Law constants for the organic COCs at the Site ranged from 1.54×10^{-1} (cDCE) to 2.33 (VC), with the exception of THF, which was present in higher concentrations and is more soluble and less volatile. Analyses described in Appendix J of the 2004 RFFS indicated that treatment of expected influent concentrations of organic COCs to ICLs/AGQSs can be accomplished at air flow rates of 1 to 2 standard cubic feet per minute (scfm) per linear foot of trench, with the exception of THF. It should also be noted that concentrations significantly higher than the expected influent concentrations of organic COCs can also be treated to ICLs/AGQSs levels, again with the exception of THF.

Although, the contribution of aerobic biodegradation to the reduction of the organic COC mass in the treatment trench may be significant, volatilization/stripping is expected to be the predominant mechanism of COC mass removal. Therefore, to be conservative, only COC mass removal via stripping was considered in evaluating the capability of the treatment trench to reduce organic COC concentrations entering the trench to acceptable concentrations (i.e., ICLs/AGQSs). A more detailed discussion of the treatment capacity of the air sparging trench is presented in Section 5.6.6 of the 2004 RFFS (pages 5-58 through 5-67).

The results of the stripping capacity analysis for THF indicated that average influent concentrations of THF (less than 146 μg/L) expected between Landfill toe well clusters MW-101 and SC-7 can be treated to ICL/AGQS levels at design air flow rates (Figure 5-7 of the 2004 RFFS). Data obtained during Phase I of the Trench PDI confirmed that THF concentrations entering the trench between well clusters SC-10 and MW-101 (located near the southwest corner of the Landfill) will likely exceed the treatment capacity of the trench. This condition will be addressed using a system of extraction wells installed near the Landfill toe, upgradient of the treatment trench, that will discharge to an *ex situ* treatment system and thence to a re-injection system located within the Landfill. Ground water re-circulated back into the Landfill will be treated to meet applicable ARARs for ground water discharges. The location of the re-injection system will have to be carefully selected to avoid adversely affecting the VOC source and remedial activities in the Northwest Landfill area. To avoid potentially adverse hydraulic effects, it may be necessary to divert some or all of the extracted THF-containing ground water to the Dover POTW together with ground water extracted from the Southern Plume. The implementability of this type of system is considered moderate because the technology is readily available and construction is not complex, but the re-injection location and rates are constrained by the need to avoid interfering with the VOC source and remedial activities in the Northwest Landfill area.

As described in Section 5.5.5.3, the aerobic conditions created in an *in situ* aerobic treatment trench are expected to cause dissolved arsenic and other reduced minerals to precipitate in the void spaces within the trench backfill material, significantly reducing the dissolved arsenic concentrations in ground water leaving the trench. Arsenic removal via co-precipitation with and sorption on metal/iron oxyhydroxides in the trench is expected to be technically feasible based upon the information summarized in Appendix K-5 of the 2004 RFFS. Uncertainty regarding the long-term effectiveness of this process, in the absence of Site-specific sorption and co-precipitation rate data and similar data from other treatment trenches, will be addressed during design. The efficiency of the aerobic co-precipitation method can be monitored by the decline in dissolved iron and arsenic concentrations in and downgradient of the trench. The long-term stability of the precipitated form of the arsenic will be evaluated during design and in post-treatment monitoring.

The treatment trench, THF *ex situ* treatment system, vertical hydraulic barrier, and natural attenuation should reliably function to reduce and remove COCs (permanently for organics) from impacted leachate and ground water. Visual inspection, water level monitoring, and ground water/surface water monitoring will be used to monitor the effectiveness of the soil cover, treatment trench, and southwest corner ground water extraction and *ex situ* treatment system. Additional remedial actions can be implemented at the Site at any time. The design and operation of the system can be modified to optimize its performance.

5.5.7.2 Uncertainties Regarding Technical Feasibility

As previously discussed, there are several uncertainties regarding the capacity and functioning of the air sparging trench and related features including:

- potential slugs of influent organic COC and arsenic concentrations that may exceed the treatment capacity of one or more trench segments;
- the adequacy of residence time in areas of the Site with higher ground water flow rates to accomplish treatment to ICLs;

- the long-term stability of arsenic-bearing solids precipitated in the trench backfill following cessation of sparging operations;
- potential hydraulic problems in the trench backfill associated with clogging of available pore space by precipitated inorganic materials, injected air, or biomass;
- potential hydraulic interferences from the Southern Plume extraction system; and
- potential adverse impacts on the VOC source and remedial activities in the Northwest Landfill area.

Data obtained from the Phase I Trench PDI did not identify areas of organic COC concentrations that exceed the trench's treatment capacity upgradient within the Landfill footprint, with the exception of THF concentrations in the area between wells SC-10US and MW-101. Furthermore, COC concentrations were found to be relatively dilute along most of the Landfill toe with the exception of THF in the southwest corner. Ground water flow rates are estimated to be the highest at the northeastern corner of the Landfill and may not provide adequate residence time for treatment of COCs to ICLs. The trench will be designed to allow conversion of the air injection wells to be used for extraction of ground water to address potential treatment capacity issues. In the particular case of arsenic, contingent measures for inadequate treatment in the trench include stabilization of arsenic upgradient of the trench using oxygen or sulfate. Removal of mineral fouling from the backfill through acid washing or backfill replacement can be used to address inadequate arsenic treatment, dissolution of precipitated arsenic when air sparging ceases, and hydraulic problems associated with backfill clogging. These uncertainties and the measures available to address them are discussed in greater detail in Section 5.6.6 of the 2004 RFFS (pages 5-69 through 5-87).

It is expected that Alternative SC-A will meet its intended objectives, based upon the available data on operating air sparging trenches (Appendix L-2 of the 2004 RFFS) and the analyses performed of key design and operating parameters (Appendices J and K-1 through K-5 of the 2004 RFFS). However, the level of uncertainty regarding two key design parameters is sufficient to warrant further evaluation in pre-design. These parameters are:

- the adequacy of ground water mixing in the trench with respect to the level of treatment achieved by mineral precipitation, and
- the effect of air flow on the effective hydraulic conductivity of the trench backfill.

The effect of limited mixing on mineral precipitation in the trench may impact the length of operation time before cleaning is required in a trench segment. If air flow occupies a substantial portion of the backfill porosity, it may reduce the hydraulic conductivity, which will also result in a shorter operating time until clogging interferes with treatment effectiveness. Addressing both of these concerns requires flexibility in the design of the backfill material (e.g., use of a coarser grade of sand) by creating a higher initial hydraulic conductivity so that it can support better mixing in the trench. As the final design of Alternative SC-A progresses, the pilot segment of the trench can be installed and operated to evaluate the need for optimizing the backfill design to address these issues.

A lower level of potential concern is associated with potential ground water mounding that may occur in or upgradient of the trench during operations. Continuous air injection into the trench will minimize the potential for a mound to persist (after a relatively short, i.e., typically hours, startup period). This effect was estimated to be negligible (Section 4.4.3.5 of Appendix N of the 2004 RFFS).

Visual inspection, water level monitoring, and ground water and surface water quality monitoring will be used to assess the effectiveness of the soil cover, the performance of the treatment trench, and the southwest corner ground water extraction and THF treatment system. Additional SC remedial actions reasonably anticipated can be implemented at the Site at any time without hindrance by the trench. The design and operation of the system can also be modified to optimize its performance.

5.5.7.3 Administrative Feasibility

Implementation of this alternative will require access restriction to the Site during construction. Consultation with federal (e.g., United States Army Corps of Engineers) and State agencies (e.g., the Wetlands Bureau of the Water Division) may be required to perform activities adjacent to and within wetland areas to comply with identified ARARs. Compliance with the substantive requirements of the City's building code and ordinances may be required for on-site treatment systems. Similarly, compliance with the substantive requirements of federal NPDES regulations will be required to discharge treated effluent to the Landfill surface or, as a contingency, to the Dover POTW.

5.5.7.4 Availability of Services and Materials

Upgrades to the protective soil cover will not be affected by availability of equipment, material, or labor. The treatment trench sparging system components are readily available. Sufficient qualified vendors and contractors are available and experienced in completing the tasks outlined in the SC-A remedy; therefore, competitive bids can be readily obtained. Because construction of deep trenches typically requires specialized equipment, bids may have to be obtained from larger and out-of-region construction firms. In addition, because installation of the trench will require specialized equipment, mobilization and use of such equipment at the Site may be controlled by its availability, thereby affecting the project schedule. Ground water collection system components (i.e., well material, pumps, header/transfer piping) are readily available. Disposal facilities are available and have the capacity to manage the relatively limited quantities of residuals that will be generated by an on-site treatment system.

5.5.8 Cost

The cost estimates for Alternative SC-A are summarized in Table 5-5, and contingency and sensitivity analyses are summarized in Table 5-6. The major capital and O&M cost components for remedy construction and operation are identified in Table 5-7. O&M costs were estimated for the number of years of expected treatment until cleanup goals are attained. A discount rate of 7 percent was used in calculating present worth values, consistent with

TABLE 5-5
SC-A SOURCE CONTROL REMEDY - TRENCH (NO CAP) - COST ESTIMATE
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

COMPONENT	QUANTITY	UNIT	UNIT COST	CAPITAL COST	ANNUAL O&M COST
SITE PREPARATION(1)					
Permitting	1	ls	$25,000	$25,000	
Site clearing, extend roads and utilities	1	ls	$290,000	$290,000	
Instrumentation & controls	1	ls	$50,000	$50,000	
Pump/control buildings	2	ea	$84,000	$168,000	
Survey, permitting, plans & misc. equipment	1	ls	$77,600	$77,600	
Alarm system	1	ls	$10,000	$10,000	
PROTECTIVE COVER MAINTENANCE(1)					
Install cover material					
1" thick layer cover over total area of 2 acres	2	acres	$29,000	$58,000	
BACKFILL PERIMETER DITCH(1)					
Backfill ditch using treatment trench spoil					
5,500 lf w/avg width 10', avg. depth 2'	1	ls	$90,000	$90,000	
4,000 cy of backfill - 30 days to complete					
Disposal of contaminated perimeter ditch soil (RCRA waste)	2,000	cy	$140	$280,000	
TOLEND ROAD VERTICAL BARRIER(1)					
Seismic monitoring	1	ls	$10,000	$10,000	
Installation of sheet piling (1,300'x50')	66,500	sf	$30	$1,995,000	
and installation of 10 dividers in treatment trench					
TREATMENT TRENCH WITH AIR INJECTION(1)					
Mobilization	1	ls	$200,000	$200,000	
Trench Installation	1	ls	$4,030,000	$4,030,000	
Trenching 3' wide x +/-50' deep x 2,900 lf					
Trench backfill, misc. construction					
On-site soil and water management	1	ls	$250,000	$250,000	
Soil stockpile sampling	1	ls	$30,000	$30,000	
Air injection system	1	ls	$349,000	$349,000	
Piping, valves and appurtenances	38,000	lf	$12	$456,000	
Pipe installation	1	ls	$25,000	$25,000	
System installation, electrical	1	ea	$12,000	$12,000	
Monitoring well/piezometer installation	30	ea	$1,850	$55,500	
Soil Disposal (10% off-site)	1,400	cy	$140	$196,000	
S.W. LOBE EXTRACTION/TREATMENT SYSTEM(1)					
Permitting - Discharge to LF surface	1	ls	$5,000	$5,000	
Mobilization	1	ls	$25,000	$25,000	
Extraction wells/re-injection gallery	1	ls	$106,000	$106,000	
Pumps, holding tanks & heated shed	1	ls	$42,000	$42,000	
Piping installation	1	ls	$48,000	$48,000	
72,000 GPD (50 GPM) treatment plant	1	ls	$648,000	$648,000	
START UP(1)	1	ls	$145,600	$145,600	
OPERATIONS & MAINTENANCE(1)					
Compressor Maintenance	1	yr	$30,000		$30,000
System Maintenance	1	yr	$5,000		$5,000
Treatment System O&M (chemicals, sampling, disposal)	1	yr	$150,000		$150,000
Monitoring - Trench Performance(3)	1	yr	$195,000		$195,000
Utilities(4)	1	yr	$400,000		$400,000
Operator & misc. equipment	1	yr	$43,500		$43,500
Sub-Total				$9,676,700	$823,500
Contingency	10	%		$967,670	
Project Management	5	%		$483,835	
Remedial Design	6	%		$580,602	
Construction Management	6	%		$580,602	
TOTAL COST				**$12,289,409**	**$823,500**
Discount Rate	7	%			
Operating Period	30	yrs			$10,218,845
PRESENT WORTH COST					**$22,508,254**

Notes:
1. This estimate is the same estimate presented in the 2004 RFFS for the Mixed Alternative Remedy with modifications noted below.
2. Adjusted to remove costs for Cocheco River Toxicity Testing.

3. Added additional annual monitoring costs to evaluate trench performance.
4. Adjusted electrical costs; engineering judgment.

TABLE 5-6
SC-A REMEDY
COST CONTINGENCIES AND SENSITIVITY ANALYSIS

SOURCE CONTROL FOCUSED FEASIBILITY STUDY
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

SC-A: COST OF CONTINGENCIES

CONTINGENCY	ADDITIONAL PRESENT WORTH COST
Two additional wells in Southwest Extraction/Treatment System-Connected to existing treatment system	$ 304,283
Removal and Disposal of As Contaminated Solids from Treatment Trench	
Removal and Reinstallation of one 300-foot section	$ 915,000
Removal and Reinstallation of two 300-foot sections	$ 1,830,000
Removal and Reinstallation of three 300-foot sections	$ 2,745,000
Increase depth of trench to 70 feet in eastern portion of trench location; approximately 1,200 linear feet. Unit adjustment estimated by dividing the lump sum cost presented in the 2004 RFFS by 2,900 feet in length and 50 feet in depth.	$ 667,034
Decrease Length of Impermeable Barrier Along Tolend Road	
600 feet length instead of 1,300 feet	$ (900,000)

SC-A: TIME SENSITIVITY ANALYSIS

REMEDY	YEARS OF OPERATION	PRESENT WORTH COST
SC-A	15	$19,789,776
	30	$22,508,254
	45	$23,493,556

USEPA guidance (USEPA, 2000).

Table 5-7. Summary of Costs for SC-A Remedy

Alternative	Capital Cost	Annualized O&M	Total Present Worth (30 years, 7%)
Presented in 2004 RFFS	$12,352,909	$283,500	$15,870,872
Adjusted Cost	$12,289,409	$823,500	$22,508,254

Notes:

1) 2004 RFFS capital cost estimate included contingent southwest corner system for THF.
2) Adjusted cost removes cost for Cocheco River Toxicity Testing, other adjustments noted in Table 5-5.

Contingency Costs/Sensitivity Analysis: The aerobic treatment trench construction costs constitute the highest single component capital cost. The trench cost is most significantly affected by the cross-sectional area of the trench to be constructed. For the 2004 RFFS, the depth of the treatment trench was estimated to be 50 feet (i.e., to the top of the clay layer), and the capital cost ($4.03 million) listed in Table 5-5 was based upon this estimated depth. Based upon observations during the Southern Plume PDI (GeoInsight, 2006) and Air Sparge Trench PDI (XDD, 2007) activities, the depth to the top of Marine Clay may be deeper in the eastern portion of the trench adjacent to the eastern Landfill lobe, potentially 70 feet BGS. The contingent cost to install a portion of the trench (1,200 feet) to a deeper elevation (70 feet BGS; i.e., 20 additional feet in depth) is identified in Table 5-6.

Costs for potential contingency remedial actions were also estimated for Alternative SC-A. For SC, these contingencies include installation of additional wells associated with the southwest corner extraction and *ex situ* treatment system, and removal and replacement of clogged backfill in treatment trench segments. The capital costs for the vertical hydraulic barrier along Tolend Road were estimated using the likely maximum length of the barrier. However, the length of the barrier could be decreased if additional modeling during pre-design indicated capture; therefore, a contingent cost to decrease the length of the vertical hydraulic barrier along Tolend Road was also included with the contingency costs. Table 5-6 presents the summary estimates of costs for contingency measures. In general, above the estimated capital cost of $12.3 million, potential contingency costs range on the order of $1.8 to $3.7 million, not including the potential reduction in cost if the vertical barrier was shortened in length.

O&M costs for Alternative SC-A are primarily affected by annual costs for electricity to run the air blowers and costs associated with compliance monitoring. For this SC-FFS, the estimated electrical costs were updated in Table 5-5. A sensitivity analysis was performed on the O&M period required for this remedial option. Variability in electricity use is not expected to significantly affect the overall remedy cost.

5.6 ALTERNATIVE SC REMEDY (SC-Ex)

5.6.1 Overview

The Alternative SC-Ex remedy is similar to Alternative SC-A as described in Section 4.5, with the modification of one primary component. The Alternative SC-Ex remedy utilizes a ground water extraction system to comply with RAOs and ARARs, instead of the on-site aerobic trench. Because ground water extraction will be implemented at the toe of the Landfill, the construction of a separate extraction system at the southwestern toe will not be needed to address elevated THF concentrations in this area.

To summarize, the following SC elements of this alternative consist of:

- augmentation and maintenance of the permeable, vegetated, protective cover currently on the Landfill;
- evaluation of the need for additional cover augmentation measures to comply with ARARs at the conclusion of the ground water remedy;
- closure of the perimeter ditch by backfilling;

- removal of sediment impacted by arsenic above 50 mg/Kg from the perimeter ditch and drainage swale;
- construction of a ground water and leachate extraction system at the toe of the Landfill, and operation of a ground water/leachate conveyance system discharging approximately 167,000 gallons per day to the Dover POTW; and
- evaluation of appropriate remedial measures for identified source areas in the Landfill that may not be adequately treated by the SC component.

5.6.2 Overall Protection of Human Health and the Environment

Alternative SC-Ex provides a high long-term overall protectiveness of human health by facilitating continued biodegradation of COCs in the Landfill waste mass and flushing residual hazardous constituents present in the Landfill to a ground water recovery system for permanent treatment. The protective soil cover on the Landfill eliminates potential dermal exposures to landfilled waste and facilitates treatment of COC-impacted wastes in the waste mass by natural attenuation processes and by flushing of leachate to the ground water recovery system for off-site treatment. Augmenting the soil cover does not involve disturbing solid waste in the Landfill, preventing potential generation of fugitive dust, organic vapors, and odors. Backfilling the perimeter ditch and excavation of drainage swale sediment hotspots that contain arsenic concentrations in excess of the 1991 ROD cleanup standards prevents human and ecological receptor exposures.

Potential future exposure to leachate or COC-impacted ground water that is currently being generated by the Landfill will be reduced or eliminated through construction of the downgradient leachate collection system and off-site treatment. If impacted ground water is discharged to the Dover POTW, protection from human exposure to extracted ground water and vapors depends on properly maintaining the transfer pipeline to the Dover POTW. Intercepting leachate-impacted ground water for treatment protects the environment by reducing impacts in local surface water bodies (the Cocheco River and the Bellamy Reservoir). Migration of arsenic in ground water and its deposition in sediments will be reduced when the SC system is in place. It should be noted that implementation of this remedial alternative will involve construction in forested wetlands that will impact the existing vegetation and habitats in the short-term, although the vast majority of these impacts can be mitigated through restoration. Extraction of leachate and impacted ground water at the Landfill toe may decrease water levels in the vicinity of the extraction system, which may reduce water levels in localized nearby wetlands.

Protection of the environment is high because of the long-term reduction and elimination or immobilization of the COCs currently present within the Landfill. The protective soil cover on the Landfill and the filled perimeter ditch will protect human and terrestrial receptors from potential exposure to Site COCs in Landfill waste and perimeter ditch sediment. The protective cover helps maintain existing vegetation, which includes poplars, and habitats on the Landfill. Maintaining the existing soil cover on the Landfill allows infiltration of precipitation into the Landfill and, hence, maintains current COC flushing and biodegradation. Poplars have been identified as effectively controlling shallow COC impacts at a number of remedial sites (Schnoor et al., 1995; Newman et al., 1997; and Schnoor, 2002). The ground water recovery system will also eliminate the long-term migration of leachate from the Site.

Filling the perimeter ditch (a component included in both SC-A and SC-Ex) will permanently alter approximately 1.2 acres of wetlands (i.e., the estimated footprint of the existing ditch, which is estimated to be 10 feet wide (on average) and 5,220 linear feet in length (Figure 4-2).

The conceptual location for construction activities associated with the extraction system wells and piping is estimated to be at the toe of the Landfill, in the general area of the filled perimeter ditch. Using the area of the filled perimeter ditch to locate SC-Ex system components minimizes the area of impact to previously undisturbed areas near the toe of the Landfill. The foot-print area of construction activities was estimated to be approximately 1.8 acres and includes the likely location of process equipment buildings. Approximately 0.8 acres of this area are characterized as forested wetlands (see Figure 4-2). Therefore, construction activities are estimated to temporarily impact an additional 0.8 acres of forested wetlands located at the toe of the Landfill along the east side of the eastern lobe, and the southernmost portion of the western lobe (i.e., adjacent to the filled perimeter ditch). This area was estimated based upon a conceptual foot-print of the area where extraction wells and associated conveyance piping will be located that overlap the forested wetlands complex. Potential impacts are characterized as temporary because areas disturbed during drilling activities and construction are anticipated to be restored through natural processes. Permanent wetland impacts are not anticipated associated with the location of the on-site equalization/storage tank and lift station (i.e., sewer system components) because these system features will be located in an area outside of the forested wetland complex. It is expected that remedial design activities associated with SC-Ex will include evaluations of design configurations that minimize impacts to the local forested wetland complex.

It is possible that ground water extraction performed as part of Alternative SC-Ex will lower the water table in the immediate vicinity of the extraction system while it is in operation. At the current level of feasibility study design (nominally 10 percent), it is not possible to reliably predict either the degree of possible water table lowering or whether the lowering will affect nearby forested wetlands. The ground water model will be used during design to evaluate possible drawdown in the vicinity of the Landfill toe; however, the actual effects of the extraction system will not be known until the system is in full operation and will be evaluated using vegetation monitoring plots. During design, potential drawdown effects will be evaluated using the model, and the system design will be iteratively adjusted to mitigate such effects to the degree practicable. The model will also be used to identify locations for vegetation monitoring plots, which will be incorporated into the long-term monitoring program.

5.6.3 Compliance with ARARs

Action-Specific: The action-specific ARARs associated with this alternative are identified in Table 5-2A located at the end of Section 5. The SC-Ex alternative will meet action-specific

ARARs. Federal and State requirements for hazardous waste landfills are not applicable to the Landfill itself because the Landfill did not receive RCRA wastes after 1980. However, because hazardous substances will temporarily remain beneath the permeable cover during treatment, certain of these requirements are relevant and appropriate. Most relevant among these requirements are those for closure and post-closure. A facility at which hazardous waste has been disposed must be closed in a manner that reduces or eliminates potential future off-site migration of hazardous wastes if such wastes are to remain on-site after closure. The proposed augmented soil cover promotes COC biodegradation within and flushing from the solid waste to permanent treatment so that hazardous constituents will not remain on-site after closure at concentrations that will adversely impact ground water. Biodegradation in the Landfill mass and the extraction and ground water treatment system address these requirements by preventing COC migration off-site. Remedy construction may produce residuals (e.g., impacted soil generated during drilling activities, excavated arsenic-impacted sediment) that are hazardous waste requiring management in compliance with RCRA. For excavated soil and sediment, RCRA will be applicable if the material is characterized as hazardous waste under RCRA regulations.

A number of federal and State requirements are applicable to construction and long-term operation of an on-site ground water and leachate collection system. Expected leachate and impacted ground water volume and quality were evaluated during the Golder PDI (Golder, 1995). The Dover POTW determined that the quality was acceptable for treatment in the Dover POTW without pre-treatment and that adequate treatment capacity existed at the City of Dover POTW for the expected flows.

<u>Chemical-Specific</u>: The chemical-specific ARARs associated with this alternative are identified in Table 5-2B located at the end of Section 5. Alternative SC-Ex will meet chemical-specific ARARs. The SC ground water treatment system will intercept COC-impacted ground water and treat it to cleanup standards, ensuring protection of downgradient ground water and surface water.

COC-impacted sediment in the perimeter ditch will be covered and arsenic hotspots in the perimeter ditch and drainage swale will be removed, thereby meeting ARARs. Mitigation measures will be employed to minimize or eliminate dust and airborne particulate matter during localized maintenance of the protective cover and other on-site activities, as warranted.

Location-Specific: The location-specific ARARs associated with this alternative are identified in Table 5-2C located at the end of Section 5. Alternative SC-Ex will meet location-specific ARARs. System design will incorporate measures to reduce potential effects of construction and operation on the local forested wetlands.

Alternative SC-Ex is considered moderate in terms of the extent of environmental impacts in wetlands in the vicinity of the extraction system because extraction may lower the water table elevation in its vicinity. By filling the perimeter ditch, it prevents future exposure to contaminated sediments, as well as potential re-contamination of the ditch sediment. On-site facilities will be sited and constructed in accordance with local building codes.

5.6.4 Long-Term Effectiveness and Permanence

Construction and operation of the extraction system at the downgradient toe of the Landfill will reliably prevent leachate and impacted ground water from migrating beyond the source area. Long-term extraction also has the potential to capture some COC mass dissolved in ground water that has migrated past the toe of the Landfill. Site COCs do not pose a potential bioaccumulation risk. Long-term O&M of the extraction system will be necessary to achieve and maintain hydraulic control and compliance with cleanup standards. Operation of this system will be relatively easy to coordinate with operation of the nearby Southern Plume remedial system.

Periodically, transfer and extraction pumps will require replacement; however, this replacement will not pose significant risks because the ground water extraction pumps can be isolated and portions of the system shutdown for maintenance, while other portions remain active. Periodically, the entire treatment system can be shutdown for a relatively short period required to complete maintenance activities without losing hydraulic control due to the relatively low flow gradients throughout most of the Site. Overall, the treatment system is expected to function adequately, and, although normal O&M will require a moderate level of effort because of the number of components of the system, potential issues encountered are expected to be predictable and easily identifiable using straightforward techniques, trouble-shooting approaches, and equipment with which there is a substantial body of field experience.

Maintenance of the Protective Cover: As for Alternative SC-A, augmentation and maintenance of the protective cover will provide effective long-term protection against contact with the solid waste present in the Landfill. On completion of the SC remedy, the cover system will be evaluated to assess whether additional measures are required to comply with ARARs for landfills at which operations ceased before 1981 and at which hazardous constituents are not adversely affecting ground water quality.

Maintenance of the permeable Landfill cover will result in continued reduction in COC mass within the Landfill through flushing and continued microbial activity sustained by infiltration and the organic matter in the solid waste. The COCs will be flushed from the Landfill solid waste to the extraction system for permanent treatment. In the long-term, there will not be untreated hazardous substances left on-site at concentrations that pose unacceptable risks. Certain residuals may require off-site disposal, principally impacted soil generated during drilling and transfer piping installation activities. Residuals will be properly handled and treated or disposed of off-site in compliance with ARARs. The quantity of residuals will depend on the number of extraction wells installed, size of the affected area traversed by the transfer piping, the nature and level of impacts in the well and piping areas, and the mode of generation (i.e., drilling versus excavation). Numerous disposal facilities are available to manage impacted soil.

Landfill Perimeter Ditch Filling: Filling of the Landfill perimeter ditch will provide effective, long-term reliability in eliminating potential exposures to potential COC-impacted sediment at the Site by eliminating the exposure pathway. Arsenic-impacted sediment removed from the perimeter ditch will require off-site disposal. Numerous disposal facilities are available to manage impacted sediment.

5.6.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

The discussion in this section is focused upon SC. MOM remedies for the Eastern and Southern Plumes were evaluated in the 1991 ROD and 2004 RFFS and selected in the 2004 AROD; they are not being re-evaluated in this report.

As described in Section 1.3.3.4 of the 2004 RFFS (pages 1-44 to 1-50), infiltrating water provides oxygen, moisture, advective transport, and dilution of the leachate. These are all important components in accelerating microbial degradative activity in the Landfill and reducing overall toxicity. The ground water extraction system will intercept ground water emanating from the toe of the Landfill, and the collected leachate will be treated at the Dover POTW, permanently reducing the toxicity and volume of the COC mass captured by the extraction system. The treatment of VOCs and arsenic at the Dover POTW is consistent with the NCP's preference for treatment.

5.6.6 Short-Term Effectiveness

Until remediation goals are met, potential future human exposures to off-site ground water impacted above AGQSs (concentrations protective of human health exposures through consumption of drinking water) are theoretically possible. However, institutional controls already established by the City of Dover and Town of Madbury, including the provision of municipal water supply, will prevent installation and use of private water supply wells in affected areas. In addition to these controls, the 2004 AROD required that a GMZ be established at the Site pursuant to New Hampshire regulations. As summarized in Section 1.4.3, the Group submitted a GMP application in November 2007 that is currently in review by the NHDES. The GMP will provide additional assurance that ground water will not be used at the Site.

The short-term effectiveness of the Alternative SC-Ex remedy is considered high. A total construction period of less than one year (i.e., one construction season) is estimated for this alternative when design is complete, including bidding, selection of a contractor, and construction of the ground water extraction and conveyance system. It is also expected that the extraction system will be fully operational within several weeks to several months of construction completion and initial system optimization.

A temporary increase in traffic, noise, and possibly nuisance dust will be associated with construction activities, primarily associated with construction of the ground water conveyance system to the City of Dover POTW. Dust emissions can be managed, as required, with standard dust control measures. Relatively few and small areas of the Landfill cover require soil augmentation and associated traffic and noise will, therefore, be limited. During the active construction period of less than one year, health risks to workers during construction may arise from potential direct contact with COC-impacted ground water and sediment during extraction well installation, transfer piping construction, and perimeter ditch closure. Use of heavy construction equipment for the active construction period poses potential risks of physical injuries. Air monitoring for organic vapors will be performed to monitor potential exposure of workers during installation of the SC components. Workers involved with O&M and monitoring activities at the Site may also be exposed to Site COCs for limited periods. The potential risks to workers will be managed by OSHA training and using safe working practices and personal protective equipment.

Construction in the forested wetlands at the margins of the downgradient Landfill toe will affect vegetation and habitat. Installation of extraction wells will likely require minimal clearing of trees and local disturbances to the wetlands. Construction of sub-grade transfer piping for extracted ground water may temporarily disturb some wetlands; however, these impacts can be mitigated through restoration. Using existing roadways within the wetlands and, when practicable, the area of the filled in perimeter ditch will reduce these disturbances. Temporary roadways may be required to provide access to certain areas for construction equipment and delivery of well and piping materials.

The short-term effectiveness of the Alternative SC-Ex remedy is considered high with regard to treatment of leachate and on-site ground water because ground water and leachate will be extracted and treated at the Dover POTW. The extraction system will prevent migration of untreated leachate and ground water to downgradient ground water and surface water bodies. If the existing cover on the Landfill is well maintained, it will continue to effectively prevent contact of human and environmental receptors with landfilled waste. The permeable cap will continue to allow the infiltration through the Landfill. This infiltration will continue to flush COCs from the Landfill waste material and promote degradation of organic material within the Landfill.

Previous RFFS modeling efforts were updated to evaluate the advective ground water flow rate associated with Alternative SC-Ex as part of an effort to preliminarily evaluate cleanup times in comparison to those for Alternative SC-A. As previously described in Section 5.5.6, the results of previous particle track simulations were revised to estimate "flow-through" times associated with four particles, particles "F" and "G" located at the upgradient (i.e., north) border of the Landfill and particles "D" and "H" located within the eastern and western lobes, respectively, of the Landfill. Modeling of particle tracks for SC-Ex (Appendix D) indicated that under extraction system operation, theoretical particle travel times from the upgradient border of the Landfill ranged from 10 to 27 years and for locations within the Landfill ranged from 1 to 9 years. As previously noted in Section 5.5.6, faster travel times were associated with particles that moved predominantly within the US unit than those that traveled in the interbedded units (i.e., the UUI and LUI). A comparison of estimated SC-Ex particle travel times with those of Alternative SC-A is presented in Section 5.7.7.

5.6.7 Implementability

5.6.7.1 Overview

The implementability of Alternative SC-Ex mirrors that of Alternative SC-A with respect to the SC components, with the exception of the aerobic trench and installation of the vertical hydraulic barrier. Therefore, the discussion in this section is focused on the implementability of a ground water extraction and piping system to transfer captured ground water and leachate to the Dover POTW for treatment. This section is divided into three categories: technical feasibility, administrative feasibility, and availability of services and materials.

5.6.7.2 Technical Feasibility

Alternative SC-Ex is highly implementable. The ground water and leachate collection and transfer systems proposed to be operated at the Landfill toe employ recovery wells and collection piping to capture COC-impacted ground water migrating from beneath the Landfill and transfer it to the Dover POTW for treatment and can be easily implemented. The POTW treats approximately 2.5 million gallons per day (gpd), and the additional 167,803 gallons that will be discharged from the Landfill to the sewer system comprises approximately 6 percent of the total flow on a daily basis. Substantial experience is available in construction and operation of the individual elements of the system, which is relatively simple to design, construct to necessary depths, and operate. The necessary equipment and techniques to construct this alternative are well understood, well developed, and readily available commercially. Sufficient land is available for construction and operation of the ground water extraction system. Operation of this remedy can be readily coordinated with that of the Southern Plume remedy; indeed, design efficiencies may be possible in terms of reduced numbers of wells and lesser ground water volumes. It can also be easily coordinated with remedial activities in the Northwest Landfill area.

Additional remedial actions can be implemented at the Site at any time and are not inhibited by the extraction and transfer system. The design and operation of the system can be readily modified to optimize its performance and to coordinate its operation with those of the nearby Southern Plume and Northwest Landfill remedial systems.

5.6.7.3 Administrative Feasibility

Implementation of this alternative will require restricting access to the Site during construction. Consultation with federal (e.g., United States Army Corps of Engineers) and State agencies (e.g., Wetlands Bureau of Water Division) may be required to perform activities adjacent to and within wetland areas consistent with identified ARARs. Air treatment is not expected to be required for operation of this alternative because collected ground water and leachate will be transferred through an enclosed piping system.

5.6.7.4 Availability of Services and Materials

Upgrades to the protective soil cover will not be affected by availability of equipment, material, or labor. The well and piping system components (i.e., well material, pumps, header/transfer pipe) are readily available. Sufficient qualified vendors and contractors are available and experienced in completing the necessary construction tasks; therefore, competitive bids can be readily obtained. Disposal facilities are available and have the capacity to manage the relatively limited quantities of residuals that will be generated during construction.

5.6.8 Cost

The cost estimates for Alternative SC-Ex are summarized in Table 5-8, and contingency and sensitivity analyses are summarized in Table 5-9. The major capital and O&M cost components for remedy construction and operation are identified in Table 5-10. O&M costs were estimated for the number of years of expected treatment until cleanup goals are attained. A discount rate of 7% was used in calculating present worth values (USEPA, 2000).

TABLE 5-8
SOURCE CONTROL SC-Ex REMEDY COST ESTIMATE
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

COMPONENT	QUANTITY	UNIT	UNIT COST	CAPITAL COST	ANNUAL O&M COST
SITE PREPARATION (1)					
Permitting	1	ls	$25,000	$25,000	
Site clearing, extend roads and utilities	1	ls	$100,000	$100,000	
Instrumentation & controls	1	ls	$50,000	$50,000	
Pump/control buildings	2	ea	$84,000	$168,000	
Survey, permitting, plans & misc. equipment	1	ls	$77,600	$77,600	
Alarm system	1	ls	$10,000	$10,000	
PROTECTIVE COVER MAINTENANCE(1)					
Install cover material					
1" thick layer cover over total area of 2 acres	2	acres	$29,000	$58,000	
BACKFILL PERIMETER DITCH(2)					
Backfill ditch using clean fill					
5,500 lf w/avg width 10', avg. depth 2'	4,000	cy	$20	$80,000	
4,000 cy of backfill - 30 days to complete					
Disposal of contaminated perimeter ditch soil (RCRA waste)	2,000	cy	$140	$280,000	
LANDFILL GW EXTRACTION WELLS(3)					
Mobilization/Demobilization	1	ea	$3,200	$3,200	
GW Extraction Wells -17 Triplets (6" steel) (4)	51	ea	$8,000	$408,000	
Submersible GW Pumps (4)	51	ea	$2,000	$102,000	
Connection Piping(4)	25,500	lf	$9.50	$242,250	
GW DISCHARGE TO POTW(3)					
Permits (River Crossing)	1	ea	$10,000	$10,000	
Mobilization	1	ea	$10,000	$10,000	
150K-gallon storage tank (5)	1	ea	$150,000	$150,000	
Trenching (2' wide x 6' deep)	6,000	lf	$16.00	$96,000	
Pipe bedding	6,000	lf	$3.22	$19,320	
Piping (8" dia HDPE)	6,000	lf	$8.46	$50,760	
Valves, fittings, controls(6)	1	ls	$40,000	$40,000	
Backfilling/compaction	2,600	cy	$2.97	$7,722	
River crossing (under river)	1	ls	$108,000	$108,000	
Sewer connection fee	1	ls	$2,270	$2,270	
Lift station (200K GPD)(7)	1	ls	$16,000	$16,000	
Manholes (pre-cast 4' ID, 6' deep)	22	ea	$920	$20,240	
GW EXTRACTION SYSTEM OPERATION(3)					
Pump replacement and repair(8)	1	yr	$36,000		$36,000
Spare parts(8)	1	yr	$15,000		$15,000
Discharge to POTW (167,803 per day)(8)	61,248	kgal	$5.33		$326,452
Extraction system maintenance	1	yr	$15,000		$15,000
Electricity (9)	1	yr	$100,000		$100,000
Sub-Total				**$2,134,362**	**$492,452**
Contingency	10	%		$213,436	
Project Management	5	%		$106,718	
Remedial Design	6	%		$128,062	
Construction Management	6	%		$128,062	
TOTAL COST				**$2,710,640**	**$492,452**
Discount Rate	7	%			
Operating Period	30	yrs			$6,110,861
TOTAL PRESENT WORTH COST					**$8,821,501**

Note:
1. This estimate is the same estimate presented in the 2004 RFFS for the Mixed Alternative Remedy.
   For Site Preparation the cost for "Site clearing, extending roads and utilities" was reduced for less intrusive implementation.
2. The quantity of backfill is based upon the estimate presented in the 2004 RFFS for the Mixed Alternative Remedy,
   however, costs for clean fill were estimated instead of use of trench spoils.
3. Based upon cost estimates for 1991 ROD Remedy presented in draft 2004 RFFS dated January 30, 2004. Modifications noted below.
4. Adjustment in number of wells and linear piping length to accommodate extraction well modeling performed by XDD dated February 13, 2009.
5. Size and cost of on-site equalization tank increased to accommodate daily flow.
6. Quadrupled cost for valves, fittings, and controls associated with sewer line upgrades.
7. Doubled lift station for increased flow volume; engineering judgement.
8. Tripled system operation costs for larger extraction system and adjusted sewer discharge rate per kilo gallon.
9. Adjusted electrical costs; engineering judgment.

TABLE 5-9
SOURCE CONTROL SC-Ex REMEDY
COST CONTINGENCIES AND SENSITIVITY ANALYSIS

SOURCE CONTROL FOCUSED FEASIBILITY STUDY
DOVER MUNICIPAL LANDFILL SUPERFUND SITE
DOVER, NEW HAMPSHIRE

SC-Ex: COST OF CONTINGENCIES

CONTINGENCY	ADDITIONAL PRESENT WORTH COST (SAVINGS)
Decrease Number of Wells - Based upon capture zones, the number of wells may be reduced. It is anticpated that fewer shallow wells will be needed operating at higher flow rates to capture ground water in the US stratigraphic unit.	
Reduce number of clusters from 17 to 12 (15 fewer wells and pumps)	($150,000.00)
Reduce number of shallow wells from 17 to 12 (5 fewer wells and pumps)	($50,000.00)
Increase number of clusters from 17 to 22 (15 fmore wells and pumps)	$150,000.00
Increase number of shallow wells from 17 to 22 (5 five more wells and pumps)	$50,000.00

SC-Ex: TIME SENSITIVITY ANALYSIS

REMEDY	YEARS OF OPERATION	PRESENT WORTH COST
SC-Ex	15	$7,195,853
	30	$8,821,501
	45	$9,410,711

Table 5-10. Summary of Costs for SC-Ex Remedy

Alternative	Capital Cost	Annualized O&M	Total Present Worth (30 years, 7%)
SC-Ex	$2,710,640	$492,452	$8,821,501

The two highest capital costs associated with Alternative SC-Ex include the ground water pumping well installations and construction of the conveyance system to the Dover POTW.

Contingency Costs / Sensitivity Analysis: Ground water extraction and treatment systems are most significantly affected by the number of extraction wells and multi-layer pumping locations that are constructed. Table 5-9 presented the sensitivity of costs related to adding or subtracting extraction wells and estimates of costs for contingency measures. In general, potential contingency costs consisting of the reduction or increase in the number of wells required could vary the estimated $2.7 million capital cost by plus or minus $50,000 to $150,000.

5.7 COMPARISON OF SOURCE CONTROL ALTERNATIVES

5.7.1 Overview

In this section, the three SC remedial alternatives, No Action, SC-A, and SC-Ex, are evaluated in comparison to one another for seven of the nine NCP evaluation criteria, defined in Section 5.2, consistent with 40 CFR 300(e)(9)(ii). State and community acceptance, the other two NCP criteria, are typically assessed in decision documents prepared by the USEPA based upon public comment.

5.7.2 Summary of New Information Affecting Remedy Evaluation

Since the 2004 RFFS was prepared, several PDIs have been undertaken that have provided new information related to conditions at the Landfill. Pertinent information relative to the discussion was presented in Section 1.4 of this report. In summary, relevant new information included:

- Southern Plume PDI results indicating that the center of mass of the migrating plume is located relatively close to the southwest corner of the Landfill footprint;
- data from the Northwest Landfill PDI indicating an area of relatively high concentrations of target COCs in northwestern corner of the Landfill;
- data from the Air Sparging Trench PDI indicating the absence of other localized areas of significant COC impacts within the Landfill footprint and at its downgradient perimeter; and
- the presence of relatively dilute concentrations of COCs along and upgradient of most of the Landfill toe.

These factors established the need for flexibility in the design and selection of a remedy that was adaptable and amenable to modification over time, as conditions change and particularly as remedial activities are performed in the Southern Plume and the Northwest Landfill hotspot area.

5.7.3 Overall Protection of Human Health and the Environment

The assessment of overall protectiveness is based upon the evaluations of long- and short-term effectiveness and of compliance with ARARs. The discussion in this section draws on those discussions in Sections 5.5.2 and 5.6.2, respectively.

Alternative SC-A and SC-Ex both provide adequate protection of human health and the environment. The SC-Ex remedy is considered more protective and more effective than SC-A in the long-term because of uncertainties associated with the treatment of arsenic and THF (two primary COCs at the Site) using the SC-A trench approach, as well as concerns about possible hydraulic interferences with the operations of the Southern Plume remedy and the Northwest Landfill VOC source and remedy. For both SC-Ex and SC-A, untreated hazardous substances will not remain on-site (in the source area) at concentrations that pose unacceptable risks to human health when RAOs are reached. Both alternatives will reduce risks to human and terrestrial receptors through active treatment, as well as access and institutional controls. ARARs will be met for these alternatives with the exception of the chemical-specific ARARs for arsenic in ground water. Because ground water is actively extracted using Alternative SC-Ex, drawdown of the water table beneath at least portions of the landfill may accelerate the capture of COCs, somewhat reducing cleanup times for this alternative in comparison to Alternative SC-A. Modeling results for arsenic indicate that it may persist at concentrations above ICLs/AGQSs for 100 years or more under both remedial alternatives, depending upon long-term ground water geochemistry.

For Alternative SC-A, arsenic-containing residuals in the treatment trench may require removal and disposal off-site. Uncertainty in the ability to clean the trench backfill with chemical treatments could increase the volume of arsenic-containing residuals. Alternative SC-Ex will not generate treatment residuals and is more protective in this respect. Sediment removed from the perimeter ditch and drainage swale will be disposed of off-site for both remedies.

Alternative SC-Ex is more protective than Alternative SC-A during the construction phase. It will require less construction time, generate significantly less truck traffic, create less noise, disturb less vegetated and wetland area, and will generate less odor and dust emissions. Alternative SC-Ex may lower the ground water table beneath wetlands in the immediate vicinity of the extraction system, potentially adversely affecting receptors in the wetlands. However, filling the perimeter ditch and eliminating water diversion from the shallow aquifer may compensate for the removal of ground water in this area. Vegetation monitoring plots will be utilized to monitor possible changes to the wetlands associated with Alternative SC-Ex. In addition, removal of COC mass from impacted ground water within the Landfill is anticipated to be accelerated under Alternative SC-Ex because of increased advective ground water flow rates associated with active ground water extraction. Otherwise, the remedies provide equivalent short-term protection. There is uncertainty for both remedies regarding the required period of operation due to potential changes in hydraulic conditions and ground water geochemistry over time. Data reviewed as part of the five-year review process will identify such changes.

The No Action Alternative will not reduce risks to human or terrestrial receptors in the short-term. However, maintenance of existing access and institutional controls will mitigate these risks. In the long-term, the No Action Alternative can be effective because natural attenuation will treat the COCs, with the exception of arsenic and possibly THF, at the Site without generating residuals. Modeling results indicated that arsenic and, under some conditions, THF will persist in ground water at concentrations above ICLs/AGQSs for 100 years or more. In the absence of construction and active treatment system operation, the local community and environment will not be disturbed with deforesting, destruction of habitat, noise, dust, truck traffic, or wetland water imbalances.

5.7.4 Compliance with ARARs

The remedial alternatives are evaluated with respect to the ARARs presented in Tables 5-2A, 5-2B, and 5-2C located at the end of Section 5.
Action-Specific: Alternatives SC-A and SC-Ex are equivalent in terms of compliance with action-specific ARARs. The No Action Alternative will comply with ARARs governing long-term monitoring. It will not comply with ARARs governing Landfill closure and remediation of contamination sources.

Chemical-Specific: ARARs will be met in the long-term by the three remedial alternatives, with the exception of arsenic and possibly THF (for the No Action remedy and Alternative SC-A) in ground water. For the three remedies, fate and transport modeling results indicate that arsenic concentrations in ground water will remain above ICLs/AGQSs for 100 years or more. Exposure pathways will be reduced or eliminated in the short-term for the duration of SC treatment by both Alternative SC-A and Alternative SC-Ex and by institutional controls governing activities in the areas of the extended plumes.

Location-Specific: The No Action Alternative provides the highest degree of compliance with location-specific ARARs because wetlands will not be disturbed. Construction of Alternative SC-Ex involves some disturbance of wetland and vegetation (approximately 2.0 acres), but not as much as required for construction of Alternative SC-A (2.4 acres). Alternative SC-A will not affect ground water table elevations beneath nearby wetlands. Impacts to local hydraulic conditions may occur under the Alternative SC-Ex remedy.

5.7.5 Long-Term Effectiveness and Permanence

Institutional and access controls currently in place will adequately protect human health for the duration of treatment.

Alternative SC-Ex provides a higher degree of long-term effectiveness and permanence compared to Alternative SC-A because of the uncertainty in long-term sequestering of arsenic and the potential inability of the trench to treat THF (e.g., without relying upon a supplementary treatment system) that could limit the effectiveness. Alternative SC-Ex employs a single technology and mechanism to treat Site COCs, increasing its reliability and effectiveness relative to Alternative SC-A. In addition, operation of the Southern Plume remedial system, given its proximity to the western end of the sparging trench, may interfere with trench hydraulics in the southwest Landfill area, as well as the THF capture, treatment, and recirculation system. Recirculation of ground water treated to remove THF into the Landfill under Alternative SC-A may cause unpredictable hydraulic effects in the Northwest Landfill area, dispersing volatile COCs found in ground water in that area and significantly hindering localized remedial activities. Alternative SC-Ex does not require a separate THF capture, treatment, and recirculation system, avoiding potential adverse effects on the Northwest Landfill source. It will be relatively easy to coordinate its operations with those in the Southern Plume, likely improving the efficiency of both remedies.

For both Alternatives SC-A and SC-Ex, a permeable soil cover will be maintained on the Landfill to prevent human and terrestrial organism exposure to Landfill solid waste and

COCs. Under both alternatives, arsenic-impacted sediment in the perimeter ditch and drainage swale will be removed for off-site treatment, protecting potential human and environmental receptors from contact with the impacted sediment. Institutional and access controls currently in place will adequately protect human health and the environment in the short-term.

Both SC remedies will effectively cut off further organic COC leachate migration into the extended plume. In addition, Alternative SC-A will introduce oxygen into a treatment/sparging trench, potentially oxygenating ground water flowing downgradient although likely for only a relatively short distance. The likelihood of either remedy altering the downgradient geochemistry to the extent that the ongoing biodegradation in the ground water plumes would cease is very low. In addition, the very high oxygen demand of the aquifer sediments (due to mineralogy and sorbed leachate-related organic material) will prevent oxygen from migrating significantly downgradient from the treatment trench.

The No Action Alternative will achieve protectiveness in the long-term, with the exception of arsenic and, in some circumstances, THF; however, the period to attain protective levels is likely to be unacceptably long.

5.7.6 Reduction of Toxicity, Mobility, or Volume Through Treatment

The effects of the SC components of the two alternatives on the reduction of toxicity, mobility, or volume of the COCs in various media at the Site are summarized in Table 5-10. The mechanisms of treatment are discussed in the detailed evaluations of the two alternatives in previous sections and are summarized for comparison in this section.

Both remedies achieve permanent reduction of toxicity, mobility, and volume of hazardous substances in the Landfill through flushing and attenuation in the Landfill bioreactor. Alternative SC-Ex permanently reduces the toxicity, mobility, and volume of COCs in ground water at the toe of the Landfill by extraction and off-site treatment using a single treatment mechanism. Alternative SC-A uses three different on-site treatment mechanisms at the Landfill toe including aerobic biodegradation and air sparging of VOCs, precipitation of arsenic, and aboveground treatment and recirculation of THF at the southwest corner of the Landfill. As discussed in Section 5.5, certain uncertainties have been identified regarding Alternative SC-A with regard to permanent sequestering of arsenic and the efficiency of THF treatment. Alternative SC-Ex is more effective in reducing toxicity, mobility, and volume of COCs because of its simpler and demonstrated capture and treatment technology for the ground water impacts observed at the Landfill site. In addition, as discussed in Section 5.7.3, because ground water is actively extracted using Alternative SC-Ex, drawdown of the water table beneath at least portions of the landfill may accelerate the capture of COCs, somewhat reducing cleanup times for this alternative in comparison to Alternative SC-A.

Table 5-11. Summary of Reduction of Toxicity, Mobility, or Volume of COCs for Remedial Alternatives

	No Action (SC-1)	SC-A	SC-Ex
Toxicity	Long-term reduction via natural attenuation for COCs, except arsenic (permanent for organics).	Reduction in COCs in solid waste and ground water via natural attenuation and flushing to treatment (permanent for organics) – multiple treatment mechanisms.	Reduction in COCs in solid waste and ground water via natural attenuation and flushing to off-site treatment (permanent for organics) – single treatment mechanism.
Mobility	Long-term reduction via natural attenuation for COCs, except arsenic (permanent for organics).	Reduction via flushing to treatment (permanent for organics) – multiple treatment mechanisms.	Reduction via flushing to off-site treatment (permanent for organics) – single treatment mechanism.
Volume	Long-term reduction via natural attenuation for organics, no reduction for arsenic.	Long-term reduction via natural attenuation and flushing to treatment for organics; no reduction for arsenic.	Long-term reduction via natural attenuation and flushing to extraction system and off-site treatment of organics and arsenic.

The quantity of ground water treatment system residuals is dependent on the volume of water treated. When RAOs are reached under Alternative SC-A, residuals will potentially include metals sludge from the treatment trench and, for the Alternative SC-Ex remedy, a relatively minor quantity of residuals from periodic cleaning of ground water extraction equipment.

Natural attenuation processes will effectively reduce the toxicity, mobility, and volume of organic COCs in Landfill solid waste and ground water, but over a longer period of time for THF under the No Action Alternative. Natural attenuation processes will reduce the toxicity and mobility of arsenic as its valence state changes in response to changes in ground water geochemistry; however, the volume of arsenic will not be reduced. Natural attenuation processes for organics do not produce residuals that require further management. No Action is less effective in reducing toxicity, mobility, and volume because of the time frames required for natural attenuation and uncertainty regarding eventual fate of arsenic.

5.7.7 Short-Term Effectiveness

Alternative SC-Ex is anticipated to have the greatest short-term effectiveness for SC because of lesser impacts during construction (e.g., noise, truck traffic, and particulate, dust, and odor emissions), and the entire system can be constructed and operational in one construction season, rather than the two to three years required to complete pilot testing and construction of the air sparging trench for Alternative SC-A. The ground water extraction system proposed for the SC-Ex remedy consists of significantly simpler technology elements to design, reliably construct at depth, and operate than the trench. Alternative SC-A is otherwise similar in short-term effectiveness with regard to the other elements of the remedy, differing primarily in activities associated with and the duration of construction of the trench.

Alternatives SC-Ex and SC-A will similarly reduce potential risks posed by perimeter ditch and drainage swale sediment by filling the perimeter ditch and removing arsenic hotspots in the drainage swale. Both alternatives will reduce the potential direct contact risks by maintaining the permeable cover on the Landfill. For both remedies, filling in the perimeter ditch will permanently disturb approximately 1.2 acres. However, the "footprint" of temporary wetland impacts is expected to be smaller and less intense for Alternative SC-Ex (approximately 0.8 acres) than Alternative SC-A (approximately 1.2 acres) because trench construction operations for SC-A will temporarily disturb a larger area of wetlands than will installation of extraction wells and transfer piping along the toe of the Landfill for SC-Ex.

The No Action Alternative will not reduce the risk to humans or terrestrial organisms through ingestion or contact with exposed COC-impacted waste in the Landfill and sediment in the perimeter ditch and drainage swale in the short term. The No Action Alternative will reduce the risk to humans through ingestion of COC-impacted ground water only through the maintenance of existing institutional controls. The No Action Alternative does not include construction activities that would disturb the local environment or the community.

As previously discussed in Sections 5.5.6 and 5.6.6, the RFFS model was used to complete a particle capture time evaluation (Appendix D) that compared the effect of pumping ground water at the toe of the Landfill (SC-Ex) on particle travel times through the Landfill to travel times associated with ambient hydraulic conditions that will be maintained by SC-A. An increase in advective ground water velocities through the Landfill is anticipated to result in faster removal of dissolved COCs from beneath the Landfill using Alternative SC-Ex as compared to Alternative SC-A. Increased hydraulic gradients associated with active ground water extraction at the toe of the Landfill associated with SC-Ex resulted in faster particle "flow-through" times through the Landfill (Table 2 of Appendix D). The reductions in comparative "flow-through" times for Alternative SC-Ex were greatest for particles located along the upgradient border of the Landfill, where travel times were reduced approximately 70 to 85 percent under SC-Ex. The maximum particle travel time associated with upgradient particle locations was reduced from 115 years under SC-A to 27 years under SC-Ex. Comparative "flow-through" times for the particles located within the Landfill lobes were either similar or were reduced approximately 40 to 66 percent under SC-Ex. The results of the particle track evaluation indicated that active extraction of ground water along the toe of the Landfill using Alternative SC-Ex is expected to accelerate the movement of dissolved COCs through the Landfill compared to Alternative SC-A (which does not result in changing the current regional hydraulic gradients).

5.7.8 Implementability

The No Action Alternative is considered the most readily implementable alternative for the

Site because it does not involve construction of treatment or capping systems, and existing monitoring wells are appropriate for the long-term monitoring component of the remedy. Additional monitoring wells can be readily installed if determined necessary in pre-design.

Alternative SC-Ex is more implementable than Alternative SC-A because its construction involves installation of extraction wells and a transfer piping system rather than a segmented, engineered trench constructed to depths of 50 feet or more within which sparging piping and complex monitoring systems must be installed. Alternative SC-A involves relatively complex construction activities that will require significant manpower, scheduling, materials, and equipment. Alternative SC-A requires that a pilot segment be constructed and tested first, which increases the overall time period of implementation. The pilot segment will allow observation and confirmation of operational parameters, but cannot be used to reliably predict long-term effectiveness. In contrast, Alternative SC-Ex is simpler to design, easier and faster to construct, and easier to operate using well understood, less mechanically complex technology that is simpler and less costly to maintain. Alternative SC-A is, therefore, intrinsically more uncertain and less reliably implemented than Alternative SC-Ex.

Although the equipment required for construction of the components of these alternatives is readily available, construction of a trench to a depth of 50 feet or more under Alternative SC-A will require more specialized equipment. The availability of specialty contractors may, therefore, affect implementation of SC components of this remedy, most likely in terms of the scheduling of the work. The components of both active remedial alternatives are commercially available and competitive bids can be obtained, although the need for specialty contractors for Alternative SC-A may limit the effectiveness of a competitive bidding process. Sufficient land is available for construction, if necessary.

It is possible to monitor the effectiveness of the components of each remedy through long-term ground water, surface water, sediment, and landfill gas monitoring; visual inspection of constructed components; and on-site treatment system effluent sampling.

Alternatives SC-Ex and SC-A are administratively more complex than the No Action Alternative. For Alternative SC-A, construction and operation of two active remedial alternatives (i.e., trench operation and ground water extraction in the southwest corner) will require coordination with local, State, and federal agencies, as necessary, particularly the NHDES Wetlands Bureau.

Site data will be reviewed every five years as part of the SARA review process. If it is determined that a portion of the implemented remedy is not performing as expected, then a contingency remedial action may be considered. Potential contingencies include:

- for Alternative SC-A, cleaning or removal of fouled backfill from the treatment trench, installation of additional wells in the southwest corner THF extraction/treatment system, and conversion of the air sparging system to ground water extraction;
- for Alternative SC-Ex, installation and operation of additional extraction wells; and
- for either Alternative SC-A or SC-Ex, if the contingencies noted in the first two bullets fail, the 1991 ROD Source Control Remedy (SC-7) will be implemented as described in the 2004 AROD (note: because this contingency was the same for both alternatives, it was not explicitly evaluated nor included in the cost estimates presented in this SC-FFS.)

Additional remedial actions to address contingencies can be readily implemented at any time; however, modifications to Alternative SC-Ex are more easily implemented and coordinated with the existing remedy and with other remedial activities at the Site.

Consistent with the 2004 AROD, the SC remedy options were evaluated with regard to coordinating their implementation with that of other Landfill remedial actions such as treatment of the Northwest Landfill VOC source and the Southern Plume ground water extraction and treatment system. The SC-Ex remedy is more easily coordinated with the Southern Plume remedy because of the similar methods of intercepting and transferring impacted ground water to off-site treatment. Use of similar technologies will eliminate the potential for hydraulic interferences between the Southern Plume extraction system and the passive flow-through the trench that are possible with Alternative SC-A. Alternative SC-Ex will also eliminate the risk of adverse impacts on the Northwest Landfill VOC source and remedy that could result from the THF treatment and recirculation system that is a likely part of Alternative SC-A.

5.7.9 Cost

Estimated total present worth costs are summarized in Table 5-12. The No Action Alternative is the lowest-cost alternative because it has no capital costs. Alternative SC-A is the highest-cost alternative because of the relatively high capital costs associated with installation of the trench. Implementing Alternative SC-Ex at the Landfill toe is more efficient (because ground water extraction will also be performed in the Southern Plume), resulting in overall reduced operational costs.

Table 5-12. Summary of Remedial Alternative Costs

Alternative	Capital Cost	Annual O&M Cost	Total Present Worth (30 years at 7%)
SC-1 (No Action)	$0	$123,065	$1,527,119
SC-A	$12,289,409	$823,500	$22,508,254
SC-Ex	$2,710,640	$492,452	$8,821,501

Costs for Alternative SC-A will be sensitive to changes in the width or depth of the trench. Based upon the Southern Plume PDI information, the eastern portion of the trench will likely be deeper. For this alternative, costs were estimated assuming that the aerobic treatment trench would be advanced into the upper portion of the Marine Clay unit at approximately 50 feet BGS and a contingent cost is presented if the clay is deeper.

Costs for Alternative SC-Ex are sensitive to the number of extraction wells proposed and the time required for ground water extraction to attain cleanup levels and the attendant estimated costs for O&M. However, proportionally, the cost of increasing the number of wells on the extraction system is far lower than expanding the trench. Cost sensitivities were summarized in Tables 5-4, 5-6, and 5-9. They included installation of additional monitoring wells (Alternative SC-1) or extraction wells (Alternative SC-Ex) and, removing, handling, and disposing of precipitates from the treatment trench (Alternative SC-A).

5.7.10 State and Community Acceptance

State and community acceptance criteria are evaluated after public comment activities and documented in draft Superfund decision documents. A summary will be included in the final draft version of this report, as directed by the USEPA.

5.7.11 Summary of Comparative Analysis

The two active source control remedial alternatives meet the threshold criteria of Overall Protection of Human Health and the Environment and Compliance with ARARs. The Alternative SC-Ex remedy is superior to Alternative SC-A because it satisfies the NCP's preference for treatment, generates a significantly smaller volume of treatment residuals, is technically more implementable and is significantly less costly. The No Action Alternative ranks lowest because it is not as protective in the short-term although it is the least expensive.

Alternative SC-A involves construction of 11 separate trench segments, each with its own set of air blowers and pressurized injection points. In addition, it includes a THF extraction, aboveground treatment, and re-injection system with multiple pieces of associated mechanical equipment. Alternative SC-Ex employs a single technology with which there is substantial experience and that is substantially less mechanically complex, employing ground water pumps that are readily available and easily and quickly replaced. With fewer and simpler mechanical elements, Alternative SC-Ex is simpler and less costly to maintain with less potential for mechanical breakdowns that will compromise its effectiveness. The revised component, Alternative SC-Ex, eliminates the uncertainties associated with design and construction of the air sparging trench in Alternative SC-A. It provides:

- permanent, effective treatment of the identified COCs without the need for complex contingency measures and far less uncertainty regarding effectiveness;
- simpler technology elements to design, construct, and operate; and

- efficient and cost-effective coordination with the Southern Plume MOM and Northwest Landfill VOC source remedies.

In addition, because ground water is actively extracted using Alternative SC-Ex, increased flow gradients in the direction of the Landfill toe may accelerate the capture of COCs, reducing cleanup times for this alternative in comparison to Alternative SC-A.

It is estimated that bringing the full air sparging trench to an operational and functional status will require a substantial period of time, currently projected to be October 2010. This lengthy schedule is necessitated by the 2004 AROD requirements for pilot testing and optimizing a single trench segment before proceeding with design and construction of the other segments. In contrast, Alternative SC-Ex does not require pre-design investigations nor pilot testing, is far simpler to design and construct, and is estimated to be completed within six to 12 months of a decision to use it, accelerating full-scale implementation of SC by more than two years.

Alternative SC-A is estimated to cost $22.5 million to construct and operate for 30 years. In addition to these costs, there are significant potential additional costs that might be incurred in the event that precipitated arsenic requires removal ($915,000 for one trench segment). In contrast, Alternative SC-Ex is estimated to cost $5.8 million to construct and operate for 30 years, substantially less than Alternative SC-A. Given the relatively dilute concentrations of COCs along and upgradient of approximately three-quarters of the downgradient Landfill toe, Alternative SC-Ex is more cost-effective than Alternative SC-A for the COC mass that must be removed and treated.

Table 5-2A. Action-Specific ARARs

Requirement	No Action Alternative	Alternative SC-A	Alternative SC-Ex Remedy
FEDERAL - 40 CFR Part 261 RCRA Standards for identification and listing of hazardous waste	Not an ARAR for this remedy.	Materials excavated during treatment trench installation will be analyzed by appropriate test methods and, if applicable, managed in accordance with the substantive requirements of the State hazardous waste regulations.	Materials generated during extraction well installation will be analyzed by appropriate test methods and, if applicable, managed in accordance with the substantive requirements of the State hazardous waste regulations.
FEDERAL - 40 CFR Part 262 RCRA Standards Applicable to Generators of Hazardous Wastes	Not an ARAR for this remedy.	Excavated materials that are determined to be hazardous wastes will be managed in accordance with the substantive requirements of the State hazardous waste regulations.	Excavated materials that are determined to be hazardous wastes will be managed in accordance with the substantive requirements of the State hazardous waste regulations.
FEDERAL - 40 CFR Part 264 RCRA Standards for Owners and Operators of Hazardous Waste TSDF Facilities	The No Action Alternative will not comply with the procedures identified for siting and securing a TSD facility.	Excavated materials that are determined to be hazardous waste will be temporarily stockpiled on-site in accordance with the substantive requirements of the State hazardous waste storage regulations.	Excavated materials that are determined to be hazardous waste will be temporarily stockpiled on-site in accordance with the substantive requirements of the State hazardous waste storage regulations.
FEDERAL - 40 CFR Part 264 Subpart AA RCRA - Air Emission Standards for Process Vents	Not an ARAR for this remedy.	If process vents are used in the remedial action, air emission controls will be implemented if the applicability threshold is met.	If process vents are used in the remedial action, air emission controls will be implemented if the applicability threshold is met.
FEDERAL - 40 CFR Part 264 Subpart BB RCRA - Air Emission Standards for Equipment Leaks	Not an ARAR for this remedy.	If equipment covered by this standard is used in the remedial action and handles hazardous substances at concentrations that meet this rule's threshold, then air emission controls will be implemented.	If equipment covered by this standard is used in the remedial action and handles hazardous substances at concentrations that meet this rule's threshold, then air emission controls will be implemented.

Table 5-2A. Action-Specific ARARs

Requirement	No Action Alternative	Alternative SC-A	Alternative SC-Ex Remedy
FEDERAL - 40 CFR Part 265 Subpart CC RCRA - Air Emission Standards for Tanks, Surface Impoundments and Containers	Not an ARAR for this remedy.	If tanks, surface impoundments, or containers are used in the remedial action and meet the applicability threshold, then air emission controls will be implemented.	If tanks, surface impoundments, or containers are used in the remedial action and meet the applicability threshold, then air emission controls will be implemented.
STATE - Env-Wm 403.6 Identification and Listing of Hazardous Wastes; Toxicity Characteristic	Not an ARAR for this remedy.	Excavated soil will be tested in accordance with this ARAR and managed appropriately.	Excavated soil will be tested in accordance with this ARAR and managed appropriately.
STATE - Env-Wm 500 Requirements for Hazardous Waste Generators [formerly He-P Ch 1905.06]	Not an ARAR for this remedy.	A temporary generator's ID may be required if soil generated during the excavation of the treatment trench is hazardous waste and requires off-site disposal. Substantive requirements of this regulation will be complied with for an on-site ground water treatment facility, if used.	A temporary generator's ID may be required if soil generated during the excavation of the extraction system conveyance piping trenches is hazardous waste and requires off-site disposal.
STATE – Env-Wm 700 Requirements for Owners and Operators of Hazardous Waste Facilities /Hazardous Waste Transfer Facilities [formerly He-P Ch 1905.08]	Implementation of this alternative will not comply with the requirements of these rules due to the presence of COC-impacted media that will not be addressed by the No Action Alternative. The No Action Alternative will not meet the siting and closure requirements, but will meet the post-closure ground water monitoring requirements.	The handling of hazardous wastes on-site will comply with this regulation.	The handling of hazardous wastes on-site will comply with this regulation..

Table 5-2A. Action-Specific ARARs

Requirement	No Action Alternative	Alternative SC-A	Alternative SC-Ex Remedy
STATE – Env-Wm 702.10 – 702.12 Monitoring [formerly He-P Ch. 1905.08(d)(6) a,b]	Implementation of the No Action Alternative will address this requirement for periodic monitoring of ground water and surface water in the drainage swale.	This requirement is applicable to this Site and the conditions present on-site. Periodic monitoring of ground water and surface water will be required in order to evaluate changes in Site conditions.	This requirement is applicable to this Site and the conditions present on-site. Periodic monitoring of ground water and surface water will be required in order to evaluate changes in Site conditions.
STATE - Env-Wm 708.2(k) Closure and Post-Closure Disposal Units	The Landfill will not be closed in a manner that will meet this requirement.	SC remedy will comply with the substantive requirements of these regulations.	SC remedy will comply with the substantive requirements of these regulations.
STATE - Env-Wm 708.3 (d)(1) Use and Management of Containers	Not an ARAR for this remedy.	If excavated materials or any other materials generated from the remedy are hazardous waste and are managed in containers, then the containers will be managed to meet the substantive portion of this requirement.	If excavated materials or any other materials generated from the remedy are hazardous waste and are managed in containers, then the containers will be managed to meet the substantive portion of this requirement.
STATE - Env-Wm 708.3(d)(2) Tanks	Not an ARAR for this remedy.	If a tank or tank system is used for storing or treating hazardous wastes as part of Site remediation, it will be constructed with secondary containment and a leak detection system and comply with monitoring and inspection requirements.	If a tank or tank system is used for storing or treating hazardous wastes as part of Site remediation, it will be constructed with secondary containment and a leak detection system and comply with monitoring and inspection requirements.
STATE – Env-Wm 708.3(d)(4) Waste Piles [formerly He-P Ch. 1905.08 (f)(1)(d)]	Not an ARAR for this remedy.	If temporary on-site storage of hazardous soils or materials is required, a structure will be designed, built, and operated in accordance with the specific requirements of this section.	If temporary on-site storage of hazardous soils or materials is required, a structure will be designed, built, and operated in accordance with the specific requirements of this section.

Table 5-2A. Action-Specific ARARs

Requirement	No Action Alternative	Alternative SC-A	Alternative SC-Ex Remedy
STATE – Env-Wm 1403 Ground Water Management and Ground Waste Release Detection Permits	The No Action Alternative will not comply with this regulation because releases to ground water would continue because COC concentrations above AGQSs would exist at property boundaries.	Capture of leachate at Landfill toe will comply with these requirements.	Capture of leachate at Landfill toe will comply with these requirements.
STATE – RSA 485-A:17 and NH Admin. Code Env-Ws 415 Terrain Alteration	Not an ARAR for this remedy.	Criteria identified in this regulation will be addressed during trench construction.	Criteria identified in this regulation will be addressed during ground water extraction system construction.
STATE – NH Admin. Code Env-A Part 1002 Fugitive Dust Control	Not an ARAR for this remedy.	The regulation will be met by maintenance of the soil protective cover.	The regulation will be met by maintenance of the soil protective cover.
STATE - Env-A300 Ambient Air Quality Standards	Not an ARAR for this remedy.	Particulate matter emissions generated during on-site activities will be controlled, if required, to ensure that the appropriate regulatory standards are met.	Particulate matter emissions generated during on-site activities will be controlled, if required, to ensure that the appropriate regulatory standards are met.
STATE - Env-A 1300 Toxic Air Pollutants	Releases of contaminants to the air from any source on-site will not exceed the respective AAL.	Releases of contaminants to the air from any source on-site will not exceed the respective AAL.	Releases of contaminants to the air from any source on-site will not exceed the respective AAL.

Table 5-2B. Chemical-Specific ARARs

Media	Requirement	No Action Alternative	Alternative SC-A	Alternative SC-Ex
Ground Water	STATE – Env-Ws 1400 Ground Water Protection Standards	AGQSs will eventually be met in on- and off-site ground water, with the exception of arsenic.	AGQSs will eventually be met in on-site ground water, after implementation of this alternative, with the exception of arsenic.	AGQSs will eventually be met in on-site ground water, after implementation of this alternative, with the exception of arsenic.
Ground Water	SDWA - MCLs (40 CFR 141.11-141.14). Revised MCLs (40 CFR 141.61-141.62) and non-zero MCLGs (40 CFR 141.50-141.51)	AGQSs will eventually be met in on- and off-site ground water, with the exception of arsenic. If a State AGQS is not established for a given constituent, or is higher, the federal MCL/MCLG will be met.	AGQSs will eventually be met in on-site ground water, after implementation of this alternative, with the exception of arsenic. If a State AGQS is not established for a given constituent, or is higher, the federal MCL/MCLG will be met.	AGQSs will eventually be met in on-site ground water, after implementation of this alternative, with the exception of arsenic. If a State AGQS is not established for a given constituent, or is higher, the federal MCL/MCLG will be met.
Ground Water	New Hampshire Drinking Water Quality Standards (Env-Ws 316, 317, 319)	AGQSs will eventually be met in on- and off-site ground water, with the exception of arsenic. AGQSs are the same as these standards.	AGQSs will eventually be met in on-site ground water, after implementation of this alternative, with the exception of arsenic. AGQSs are the same as these standards.	AGQSs will eventually be met in on-site ground water, after implementation of this alternative, with the exception of arsenic. AGQSs are the same as these standards.
Ground Water Surface Water	FEDERAL – USEPA Risk RfDs	RfDs will be used to characterize risks associated with residual COC concentrations.	RfDs will be used to characterize risks associated with residual COC concentrations.	RfDs will be used to characterize risks associated with residual COC concentrations.
Ground Water Surface Water	FEDERAL – USEPA Carcinogen Group Potency Factors	CPFs will be used to characterize risks associated with residual COC concentrations.	CPFs will be used to characterize risks associated with residual COC concentrations.	CPFs will be used to characterize risks associated with residual COC concentrations.

Table 5-2C. Location-Specific ARARs

Media	Requirement	No Action Alternative	Alternative SC-A	Alternative SC-Ex
Wetlands	FEDERAL – CWA Section 404; 40 CFR Part 230:33 CFR Parts 320-330	Any monitoring activities in the wetland will comply with these regulations.	Material excavated during construction of the aerobic treatment trench will be placed on the on-site landfill, backfilled in the perimeter ditch, or disposed off-site. Material excavated during construction of the on-site treatment system will be placed in the Landfill unless it is determined to be hazardous and does not meet the exemptions of the land disposal restrictions, in which case it will be shipped off-site for treatment and disposal.	Material excavated during construction of the ground water extraction system conveyance piping will be placed on the on-site landfill, backfilled in the perimeter ditch, or disposed off-site unless it is determined to be hazardous and does not meet the exemptions of the land disposal restrictions, in which case it will be shipped off-site for treatment and disposal.
Wetlands	Federal Executive Orders 11990 Protection of Wetlands FEDERAL – 40 CFR Part 6 Appendix A	Any monitoring activities in the wetland will comply with these regulations.	Impacts to wetlands bordering the Site will be minimized by including mitigative measures during on-site construction activities.	Impacts to wetlands bordering the Site will be minimized by including mitigative measures during on-site construction activities.
Land	FEDERAL – RCRA General Facility Standards 40 CFR 264.18(a) Seismic Standards	Not an ARAR for this remedy.	Construction of any on-site treatment facility will consider this location standard in design.	Not an ARAR for this remedy.

Table 5-2C. Location-Specific ARARs

Media	Requirement	No Action Alternative	Alternative SC-A	Alternative SC-Ex
Wetlands	FEDERAL – 16 USC 661 et. seq., Fish and Wildlife Coordination Act	Not an ARAR for this remedy.	Specified federal agencies will be contacted to help analyze impacts of remedial activities on wildlife in wetlands and the river.	Specified federal agencies will be contacted to help analyze impacts of remedial activities on wildlife in wetlands and the river.
Wetlands	STATE – RSA 482-A and Env-Wt 300 - 400, 600, New Hampshire Criteria and Conditions for Fill and Dredging in Wetlands	Not an ARAR for this remedy.	Work plans associated with activities adjacent to the Site will be reviewed by the Wetlands Board and will comply with applicable substantive wetland protection requirements.	Work plans associated with activities adjacent to the Site will be reviewed by the Wetlands Board and will comply with applicable substantive wetland protection requirements.

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